U.S. Environmental Protection Agency
Region 2

Response Action Contract

FINAL
FEASIBILITY STUDY REPORT
FOR OPERABLE UNIT NOS. 3 & 5
ROEBLING STEEL COMPANY SITE
FLORENCE TOWNSHIP, NEW JERSEY

JULY 2002

Contract No: 68-W-98-214

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

USEPA WORK ASSIGNMENT NUMBER: 001-RICO-0291
USEPA CONTRACT NUMBER: 68-W-98-214
FOSTER WHEELER ENVIRONMENTAL CORPORATION
RAC II PROGRAM

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LIST OF ACRONYMS

ABLC	Alpert Brothers Leasing Company
ARARs	Applicable or Relevant and Appropriate Requirements
AST	Aboveground Storage Tank
AWQC	Ambient Water Quality Criteria
bgs	below ground surface
CEA	Classified Exception Area
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CF&I	Colorado Fuel and Iron Company
cfs	cubic feet per second
COC	Chemicals of Concern
COPC	Contaminants of Potential Concern
COPEC	Contaminant of Potential Ecological Concern
CP	Chlorinated polyethylene
CPI	Corrugated Plate Interceptor
CT	Central Tendency
cy	cubic yard
DER	Declaration of Environmental Restriction
DOT	Department of Transportation
DRBC	Delaware River Basin Commission
EP	Extraction Procedure
ERA	Ecological Risk Assessment
FFS	Focused Feasibility Study
FS	Feasibility Study
FWENC	Foster Wheeler Environmental Corporation
GMS	Groundwater Modeling System
gpm	gallons per minute
HDPE	High Density Polyethylene
HQ	Hazard Quotient
IGWSCC	Impact to Groundwater Soil Cleanup Criteria
JARSCO	John A. Roebling Steel Company
LEL	Low Effects Level
LOAEL	Lowest Observed Adverse Effects Level
MCL	Maximum Contaminant Levels
MEK	methylethylketone
mg/kg	milligram per kilogram
mi^2	square mile
MLLW	Mean Lower Low Water
mph	miles per hour
msl	mean sea level
NCP	National Contingency Plan
ND	Not Detected
NESHAP	National Emission Standards for Hazardous Air Pollutants
NJDEP	New Jersey Department of Environmental Protection
NJ-GWQS	New Jersey Groundwater Quality Standards
NOAEL	No Observable Adverse Effects Limit

NRDCSCC	Non-Residential Direct Contact Soil Cleanup Criteria
OU	Operable Unit
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
Pb	lead
PCB	Polychorinated Biphenyl
PIR	Pre-Design Investigation Report
POTW	Publicly Owned Treatment Works
PPE	Personal Protective Equipment
PRAP	Proposed Remedial Action Plan
PVC	Polyvinyl Chloride
RAB	Removal Action Branch
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDCSCC	Residential Direct Contact Soil Cleanup Criteria
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
ROD	Record of Decision
ROW	Right-of-Way
RSC	Roebling Steel Company Site
RWC	Roebling Wire Company
SEL	Severe Effects Level
SRI	Supplemental Remedial Investigation
SSL	Soil Screening Level
SVOC	Semi-volatile Organic Compound
TBC	To Be Considered
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TI	Technical Impracticability
TSD	Treatment, Storage, and Disposal
TSS	Total Suspended Solids
UCL	Upper Confidence Limit
ug/L	Micrograms per Liter
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USTs	Underground Storage Tank
UV	Ultraviolet
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

Foster Wheeler Environmental Corporation (FWENC) has prepared this Feasibility Study (FS) for Operable Unit 3 (OU-3) and Operable Unit 5 (OU-5) at the Roebling Steel Company Site (RSC) in response to Work Assignment Number 001-RICO-0291 issued by the United States Environmental Protection Agency (USEPA) under RAC II Contract Number 68-W-98-214. This Work Assignment was issued to perform a Supplemental Remedial Investigation/Feasibility Study (RI/FS) to address contaminated soils, sediments, and groundwater.

The RSC is located on over 200 acres of land in Florence Township, Burlington County, New Jersey, and was actively used from 1906 to 1985 for various industrial purposes, but primarily for the fabrication of steel wire. The wire production process resulted in the generation of significant quantities of waste materials in both liquid and solid forms. The majority of liquid wastes were discharged to Crafts Creek and the Back Channel of the Delaware River. Large quantities of solid wastes including slag, mill scale, used refractory materials, and other production residues were disposed at the site. Numerous buildings, storage tanks, and piping systems were abandoned at the site. On-site soils and groundwater, as well as sediments in the Back Channel of the Delaware River, have been contaminated by historical site operations. As a result of on-site contamination, the site poses excess carcinogenic and non-carcinogenic risks primarily to individuals who may be present on the site for significant time periods in the future. In addition, the site poses a risk to ecological systems and benthic communities.

The USEPA has taken several actions at the RSC, including the performance of removal actions and the remediation of OU-1 and OU-2 (drum wastes, chemicals, transformers, baghouse dust, tires, tank wastes, and contaminated soils in the park area). In addition, Records of Decision (ROD) for OU-3 and OU-4 were signed to remediate the Slag Disposal Area along the Delaware River and the buildings, tanks/piping, respectively. Soils, sediments, and groundwater constitute OU-5. OU-5 is the subject of this FS, which is based on the Final Remedial Investigation (RI) Report for Operable Unit No. 5 (FWENC, 2002). In addition, since the OU-3 Pre-Design Investigations have identified substantially larger quantities of impacted material in the Slag Disposal Area than originally estimated in the OU-3 ROD, this FS presents data for the Slag Disposal Area to support the OU-3 ROD amendment.

The purpose of the RSC FS is to identify and evaluate remedial alternatives for the contaminated soils, sediment, and groundwater within the RSC. This FS Report was prepared using the data and information presented in the Final RI Report for Operable Unit No. 5 (FWENC, 2002) and follows the procedures outlined in the USEPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA - Interim Final" (USEPA, 1988a). The contents of the RSC FS will be used to formulate a Proposed Remedial Action Plan (PRAP). The PRAP will be distributed for public comment and will form the basis for the ROD for OU-5 and the revised ROD for OU-3. The PRAP will include the recommended alternatives for soil, sediment, and groundwater contamination at these operable units.

Remedial activities for other OUs of the RSC (i.e. OU-1, OU-2, OU-3, and OU-4) have already been completed or are currently taking place. OU-1 consisted of on-site items which posed a sufficiently imminent hazard and were not addressed in the previous removal actions. These items included the removal of remaining drums, nine exterior tanks, transformers, a Bag House dust pile, chemical piles, tires, and soil under the water tower in the Roebling Park.

OU-2 consisted of removing contaminated soil in the Southeast Park. This completed remedial action included excavation of approximately 140 cubic yards (cy) of contaminated soil located in three areas of the park for off-site disposal and backfill of the excavated area with clean soil and revegetation.

As part of the 1990 ROD for OU-3, USEPA selected a remedy for the 34-acre Slag Disposal Area, which included treating hot spots of contamination and then covering the entire 34-acre Slag Disposal Area with a soil cover and vegetation, a stormwater management system, shoreline protection, and institutional controls. The United States Army Corps of Engineers (USACE) completed the 95 percent design for the Slag Disposal Area in July 1997 and completed a Pre-Design Investigation for the Slag Disposal Area in May 1999.

The OU-3 Pre-Design Investigation indicated that the quantity of slag material exceeding the TCLP criteria, and therefore requiring treatment, was substantially higher than the quantity estimated in the FFS and included in the 1990 ROD. The investigation also indicated that the slag material and groundwater did not have a significant impact on sediment biota and surface water quality, and that metals present in groundwater were principally suspended particulates. Therefore, it was determined that the application of the TCLP test was inappropriate, and the impacts of the slag material would be investigated further as part of the OU-5 RI.

The OU-4 ROD focused on the remediation of 70 abandoned buildings that contain contaminated process dust on the walls and floors, contaminated residue and materials in or on process equipment, tanks, pits, sumps, underground piping systems, and damaged friable asbestos. Site work completed thus far includes demolition of 25 buildings and mitigation of 11 underground storage tanks and four aboveground oil storage tanks. Site work continues on gross decontamination of 16 buildings, removal of underground oil transport lines and chemical lines, segregating demolition debris, recycling steel debris, and disposal of all wastes generated as a result of construction activities. This remedial action is still ongoing.

OU-1 and OU-2 would not affect the remedial activities associated with OU-5. As discussed above, based on the OU-3 Pre-Design Investigation, additional investigation of the Slag Disposal Area was performed during the OU-5 RI, and a re-evaluation of remedial alternatives for the Slag Disposal Area was included in the OU-5 FS to support an OU-3 ROD amendment. OU-4 remedial activities included the management of impacted soil. However, the volume of soil managed would not have any substantial affect on the OU-5 remedial actions.

As part of the RI, multiple phases of field investigations were performed to characterize soil, groundwater, seeps, surface water and sediments associated with the RSC. Based on these investigations, it was determined that the primary contaminants of concern for soils include arsenic, chromium, lead, and polynuclear aromatic hydrocarbons (PAHs). The primary contaminants of concern for sediments include PAHs and inorganics. The primary contaminants of concern for groundwater include inorganics and low-level organics.

To summarize the material quantities, OU-3 is considered to be the 34-acre Slag Disposal Area and consists only of slag. OU-5 consists of soil, sediment, and groundwater. Although some slag may be present outside the limits of the 34-acre Slag Disposal Area, the areas and volumes of contaminated material (i.e. soil and slag) for OU-5 were determined using analytical data compared to New Jersey Residential Direct Contact Soil Cleanup Criteria (NJ RDCSCC); no distinction was made between soil and the underlying slag for OU-5.

The calculated containment areas for soil (OU-5) and slag (OU-3) are 592,000 square yards and 165,000 square yards, respectively. The corresponding excavation volumes are 861,000 cubic yards (cy) for soil (OU-5) and 710,000 cy for the slag material (OU-3). Approximately 30 percent of both the excavated soil and slag material is assumed to be hazardous and must be disposed accordingly. The sediment area was calculated as 87,000 square yards, equating to a total dredging volume of 116,000 cy. Based on the comprehensive groundwater contaminant flow modeling, restoration via pump-and-treat would require a 35,000-year duration at a rate of 93 gallons per minute. Thus, the total volume of groundwater to be remediated is 1.7 trillion gallons.

A three-dimensional groundwater model (Appendix D) was developed for the RSC, which included the development of a calibrated steady-state groundwater flow model for the site, the development of a transient contaminant transport model for the site, and the simulation of various groundwater remediation scenarios using the transport model. One of the outcomes of the detailed groundwater modeling performed for the RSC was to provide adequate data to support a Technical Impracticability (TI) Waiver prior to implementation of a remedial system.

The TI Waiver is being sought site-wide for the contaminated groundwater plume. The TI Evaluation (Appendix E) for OU-5 is provided for the additional clarification of the TI aspects of the groundwater restoration alternative. In addition to evaluating the timeframe of remediation, the difficulty in extracting certain contaminants from the aquifer, and the large spatial area of site-wide contamination, present worth cost is also considered as a factor, because of the inability to achieve groundwater ARARs or target cleanup levels in a reasonable timeframe and the inordinate cost of complying with those ARARs.

The following remedial action objectives (RAOs) concerning all OUs have been developed for the contaminated media at the RSC:

Soil

- Reduce human health risks associated with direct contact to contaminated site-wide soils based on current and anticipated future use. Redevelopment plans have not been made for the site, but residential use has been eliminated as an option;

- Reduce risks to ecological receptors due to exposure to contaminated soils to acceptable levels; and

- Comply with ARARs and TBCs consistent with current and anticipated future use, or request waivers.

Sediment

- Reduce risks to ecological receptors due to exposure to contaminated sediments to acceptable levels; and

- Comply with ARARs and TBCs, or request waivers.

Groundwater

- Reduce human health risks associated with exposure to contaminated groundwater;

- Minimize any further adverse impacts to groundwater;

- Mitigate the inhalation of vapors from, ingestion of, and dermal contact with groundwater as tap water (future receptors);

- Minimize migration of contaminated groundwater off-site; and

- Comply with Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered Materials (TBCs) consistent with current and anticipated future use, or request waivers.

Remedial alternatives to meet the RAOs were developed by combining representative process options from technically feasible technology types. Initially, six alternatives were developed for soils; five alternatives were developed for sediments; and four alternatives were developed for groundwater. The developed alternatives were screened based on effectiveness, implementability and cost, and only the most promising alternatives were carried forward for detailed evaluation. These alternatives are presented below.

Soil

Alternative SL1:	No Action
Alternative SL2:	Limited Action
Alternative SL3:	Containment Option (a): Asphalt Capping and Soil Cover Option (b): Soil Cover
Alternative SL4:	Source Removal/Off-Site Disposal

Sediment

Alternative SD1:	No Action
Alternative SD2:	Limited Action
Alternative SD3:	Containment
Alternative SD4:	Dredging/Dewatering/Off-Site Disposal
Alternative SD5:	Dredging/Dewatering/On-Site Disposal

Groundwater

Alternative GW1:	No Action
Alternative GW2:	Limited Action
Alternative GW4:	Restoration (Extraction Wells for Pump-and-Treat)
	Option (a): With Source Removal
	Option (b): Without Source Removal

These alternatives were evaluated with respect to the following seven criteria: (1) overall protection of human health and the environment; (2) compliance with ARARs/TBCs; (3) long-term effectiveness; (4) reduction of toxicity, mobility, and volume; (5) short-term effectiveness; (6) implementability; and (7) cost.

COMPARATIVE ANALYSIS OF SOIL ALTERNATIVES

<u>Overall Protection of Human Health and the Environment</u>: Alternative SL4 is the most protective of human health and the environment, since contaminated material is removed from the site. Alternative SL3 achieves the RAOs of protecting human health and ecological receptors by preventing exposure to contaminated soil, but does not completely eliminate the risk associated with the contamination, since contaminated material remains on site. Alternative SL2 is protective of human health via institutional controls (e.g., use restrictions), but is not protective of the environment. Alternative SL1 is not protective of human health and the environment.

<u>Compliance with ARARs</u>: Alternatives SL1, SL2, and SL3 would not achieve chemical-specific ARARs/TBCs. SL4 is the only alternative that would achieve chemical-specific ARARs/TBCs. All the alternatives would be implemented in accordance with location and action-specific ARARs, as applicable.

<u>Long-Term Effectiveness and Permanence</u>: The long-term effectiveness is lowest for Alternatives SL1, SL2, which do not include containment or removal of contamination. Alternative SL3 is more effective in the long-term, since contaminated materials are contained; however, long-term maintenance would be required to ensure the containment is not breached. Alternative SL4 is the most effective in the long-term since contaminated material is removed from the site.

<u>Reduction of Toxicity, Mobility or Volume</u>: Alternatives SL1 and SL2 provide no reduction in the toxicity, mobility or volume of contaminants. Alternative SL3 reduces the mobility of the contaminants by reducing erosion and infiltration. Alternative SL4 significantly reduces the toxicity, mobility, and volume of contaminants by removing the contaminated soils and slag material.

<u>Short-Term Effectiveness</u>: No additional short-term adverse impacts to the community would be expected from the implementation of Alternatives SL1 and SL2. Alternative SL3 would include a limited risk due to disturbance of the site soils and increased truck traffic. Alternative SL4 could create particulate emissions from the source removal activities. Engineering controls would be expected to mitigate most of the risks. Potential impacts on workers during remedial actions would be negligible for Alternatives SL1 and SL2, slightly greater for Alternative SL3, and greatest for Alternative SL4. Engineering controls, personal protective equipment (PPE) and safe work practices would be used to address potential impacts to workers. No potential environmental impacts would

be expected from the implementation of Alternatives SL1 and SL2, although existing impacts would remain unmitigated. For Alternatives SL3 and SL4, clearing and excavation would impact wildlife habitats; however, these areas would be restored as part of the remediation.

Implementability: For Alternatives SL1 and SL2, no constructability concerns exist. Constructability concerns are associated with Alternatives SL3 and SL4. All alternatives would include periodic reviews and inspections as a means of monitoring the effectiveness of the remedy, except for Alternative SL4. Services and materials are readily available for all alternatives; however, some difficulty would be encountered due to the excessive volumes of material and the large size of the slag "boulders." There is some level of difficulty in the implementation of Alternative SL4. The first difficulty is locating an appropriate disposal facility for the excessive volumes of excavated soil. Also, there may be difficulty if the water table (i.e. groundwater) or river water is encountered during excavation of soils along the shorelines and throughout the RSC, as it may involve pumping water from excavations or dewatering soils from the deeper excavations.

Cost: Alternative SL1 is the least cost alternative; there are no capital costs and no annual O&M costs (however, costs for five-year reviews in accordance with CERCLA are included). Alternative SL2 is the next lowest cost alternative. Alternative SL3 is the next lowest cost alternative and is the lowest cost alternative that meets the RAOs for the site. Alternative SL4 is the highest cost alternative; this alternative also meets the RAOs for the site.

COMPARATIVE ANALYSIS OF SEDIMENT ALTERNATIVES

Overall Protection of Human Health and the Environment: RAOs are not achieved by Alternative SD1. Alternative SD2 relies on institutional controls to improve overall protection of human health and the environment. Natural processes would not effectively reduce risks in a reasonable time frame. Alternative SD3 achieves the RAOs of protecting human health and ecological receptors by preventing exposure to contaminated sediments and restoring ecologically sensitive areas. Alternatives SD4 and SD5 are aggressive strategies that would achieve the RAOs.

Compliance with ARARs: Alternatives SD1 and SD2 would not achieve contaminant-specific ARARs/TBCs. Alternatives SD4 and SD5 most aggressively attempt to achieve chemical-specific ARARs/TBCs, followed by Alternative SD3. All the alternatives would be implemented in accordance with location- and action-specific ARARs, as applicable.

Long-Term Effectiveness: The magnitude of residual risks are highest for Alternatives SD1, SD2, and SD3, and significantly reduced for Alternatives SD4 and SD5. Long-term residual risks may be lowest for Alternative SD4, which involves off-site disposal of contaminated materials. Alternative SD2 relies on institutional control measures that are less reliable. Alternative SD3 uses capping of contaminated sediments, which is an effective means of preventing direct contact exposure, but would be subject to erosion and may not be permanent. Alternatives SD4 and SD5 eliminate the risk associated with contaminated material from the site through removal.

Reduction of Toxicity, Mobility or Volume: Alternatives SD1 and SD2 provide no reduction in the toxicity, mobility or volume of contaminants. Alternative SD3 reduces the mobility of the contaminants by containment. Alternatives SD4 and SD5 significantly reduce the mobility and volume by removal.

Short-Term Effectiveness: No short-term adverse impacts to the community would be expected for Alternatives SD1 and SD2. Alternative SD3 would include a limited risk due to disturbance associated with the removal of sediments. Alternative SD4 would increase truck traffic and noise in the surrounding community, and would create potential hazardous waste spills in the community from the transportation of contaminated material. Engineering controls would be expected to minimize and/or mitigate most of the risks. Potential impacts on workers during remedial actions would be negligible for Alternatives SD1 and SD2, slightly greater for Alternative SD3, and greatest for Alternatives SD4 and SD5. Engineering controls, PPE, and safe work practices would be used to address potential impacts to workers. No potential environmental impacts would be expected from Alternatives SD1 and SD2, although existing impacts would remain unmitigated. For Alternatives SD3 through SD5, dredging would impact wildlife habitats; however, it is expected to be temporary. Construction activities would be performed so as to minimize the impacted area. Disturbance of wetland areas would be minimized to the extent possible, and protection would be provided when work must occur in these areas. Also, the site would be restored upon completion of the remedial construction.

Implementability: For Alternatives SD1 and SD2, no constructability concerns exist. Services and materials are readily available for all alternatives. Alternative SD3 would require careful construction to effectively place the cap and vegetation, so as to prevent erosion. Alternative SD4 would have requirements for the waste transport off-site. Alternatives SD3 through SD5 would have to meet substantive requirements for dredging of sediments. Additional coordination with soil remedy implementation is also necessary for placing sediments on-site.

Cost: Alternative SD1 is the least cost alternative; there are no capital costs and no annual O&M costs (however, costs for five-year reviews in accordance with CERCLA are included). Alternative SD2 is the next lowest cost alternative. Alternative SD3 is the next lowest cost alternative, and is the lowest cost alternative that meets the RAOs for the site. Alternatives SD4 and SD5 are the highest and second highest cost alternatives, respectively; these alternatives meet the RAOs for the RSC.

COMPARATIVE ANALYSIS OF GROUNDWATER ALTERNATIVES

Overall Protection of Human Health and the Environment: RAOs are not achieved by Alternative GW1. Alternative GW2 relies on institutional controls to improve overall protection of human health; however, it is not protective of the environment. Natural processes would not effectively reduce risks in a reasonable time frame. Alternative GW4 is an aggressive strategy that would achieve the RAOs by extraction and treatment of the groundwater and would significantly reduce the toxicity, mobility or volume of contaminants over an extended time period.

Compliance with ARARs: Alternative GW1 would not achieve compliance with chemical-specific ARARs since contaminants are not removed to cleanup levels. Since the source of groundwater contamination is not removed, Alternative GW2 would not achieve compliance with chemical-specific ARARs; however, location- and action-specific ARARs would be followed, or waivers would be obtained as necessary. Alternative GW4 most aggressively attempts to achieve compliance with chemical-specific ARARs since the contaminated groundwater would be removed and treated. In addition, GW4 would meet location- and action-specific ARARs.

Long-Term Effectiveness: Alternative GW1 is not effective, since it provides no protection of human health or the environment. Alternative GW2 relies on water use restrictions as control measures to protect human health, but offers no protection to the environment. Alternative GW4 extracts and treats the contaminated groundwater, thereby eliminating a larger volume of the contaminants. In addition, the remedial measures and treatment technologies used in GW4 are irreversible and permanent; however, protection of human health and the environment would not be achieved for a very long period of time.

Reduction of Toxicity, Mobility or Volume: Alternatives GW1 and GW2 provide no reduction in the toxicity, mobility or volume of contaminants via treatment at the site. Over an extended period of time, Alternative GW4 reduces the toxicity, mobility, and volume of the contaminants via removal and the groundwater treatment system.

Short-Term Effectiveness: No additional short-term adverse impacts to the community would be expected from Alternatives GW1 and GW2. Alternative GW4 would include a limited risk due to some disturbances of the site soils, increased truck traffic, and noise during construction of the groundwater treatment system. Engineering controls would be expected to mitigate most of the risks. Potential impacts on workers during remedial actions would be negligible for Alternatives GW1 and GW2, and greatest for Alternative GW4. Engineering controls, PPE and safe work practices would be used to address potential impacts to workers. Alternative GW4 has the greatest potential impact to workers due to the use of on-site, *ex situ* treatment processes. The additional equipment and treatment chemicals present additional hazards beyond the construction and handling hazards present in the other alternatives. No potential environmental impacts would be expected from Alternatives GW1 and GW2 although existing impacts would remain unmitigated.

Implementability: For Alternatives GW1 and GW2, no constructability concerns exist. Alternative GW4 uses demonstrated and proven treatment technologies. Some engineering studies would need to occur during the design phase to optimize operating parameters. All the alternatives would include periodic reviews and inspections as a means of monitoring the effectiveness of the remedy. Services and materials are readily available for all the alternatives. Since Alternative GW4 uses common and commercially-available equipment, it is anticipated that contractors and vendors would continue to be available at the time of implementation. Alternative GW4 would have additional requirements for operations, regarding groundwater extraction measures and the treatment system, respectively.

Cost: Alternative GW1 is the least cost alternative; there are no capital costs and no annual O&M costs (however, costs for five-year reviews in accordance with CERCLA are included). Alternative GW2 is the next lowest cost alternative. Alternative GW4 is the highest cost alternative and is the only alternative that meets the RAOs (over time) for the RSC, although this alternative has been deemed technically impracticable.

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1.0 INTRODUCTION

1.1 PURPOSE AND ORGANIZATION OF REPORT

Foster Wheeler Environmental Corporation (FWENC) has prepared this Feasibility Study (FS) Report for Operable Unit 3 (OU-3) and Operable Unit 5 (OU-5) in response to Work Assignment Number 001-RICO-0291. This Work Assignment was issued by the United States Environmental Protection Agency (USEPA) under RAC II Contract Number 68-W-98-214 to perform a Supplemental Remedial Investigation/ Feasibility Study (RI/FS) for the Roebling Steel Company Site (RSC). This FS Report for OU-5, which addresses contaminated soils, sediments, and groundwater, was prepared in accordance with the Final Project Plans for the Feasibility Study (Ebasco, 1995).

The RSC is located on over 200 acres of land in Florence Township, Burlington County, New Jersey, and was actively used from 1906 to 1985 for various industrial purposes, but primarily for the fabrication of steel wire. The wire production process resulted in the generation of significant quantities of waste materials in both liquid and solid forms. The majority of liquid wastes were discharged to Crafts Creek and the Back Channel of the Delaware River. Large quantities of solid wastes including slag, mill scale, used refractory materials, and other production residues were disposed at the site. Numerous buildings, storage tanks, and piping systems were abandoned at the site. On-site soil and groundwater, as well as sediments in the Back Channel of the Delaware River, have been contaminated by historical site operations. As a result of on-site contamination, the site poses carcinogenic and non-carcinogenic risks primarily to individuals who may be present on the site for significant time periods in the future.

The USEPA has taken several actions at the RSC, including the performance of removal actions and the remediation of OU-1 and OU-2 (drum wastes, chemicals, transformers, baghouse dust, tires, tank wastes, and contaminated soils in the park area). In addition, Records of Decision (RODs) for OU-3 and OU-4 were signed to remediate the Slag Disposal Area along the Delaware River, and the buildings and tanks/piping, respectively. Soils, sediments, and groundwater constitute OU-5. Information and data for OU-3 are based on the Pre-Design Investigation and the OU-3 ROD amendment. OU-5 data are based on the RI for this Operable Unit (FWENC, 2002).

The purpose of the RSC FS for OU-5 is to identify and evaluate remedial alternatives for the contaminated soils, sediments, and groundwater within the RSC. Since the OU-3 Pre-Design Investigations have identified substantially large quantities of impacted material in the Slag Disposal Area than originally estimated in the OU-3 ROD, this FS presents data for the Slag Disposal Area to support the OU-3 ROD amendment. It should also be noted that this FS presents a re-evaluation of the remedies and not a re-evaluation of OU-3 data. This report documents the application of the FS process, as described in the "Guidance for Conducting Remedial Investigations and Feasibility Studies Under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) - Interim Final" (USEPA, 1988a), to OU-5. In general, this process begins with establishing remedial action objectives (RAOs) to address the risks posed by the contaminants associated with OU-5. General response actions are then developed for each medium (i.e., soil, sediment, and groundwater) of interest that can address the RAOs. The identification and screening of technologies applicable to each general response action is the next step in the FS process.

Following the screening of technologies, representative process options are combined to form remedial alternatives. The remedial alternatives are screened to determine which alternatives are candidates for detailed evaluation. The detailed evaluation is conducted by applying the following seven criteria: short term effectiveness; long term effectiveness; reduction of toxicity, mobility or volume; implementability; cost; compliance with Applicable or Relevant and Appropriate Requirements (ARARs); and overall protection of human health and the environment. Two additional evaluation criteria, state and community acceptance, are evaluated after the Draft Final FS Report is prepared and prior to issuance of the ROD.

This FS Report is comprised of an Executive Summary, five sections, and appendices. The organization and content of the report are as follows:

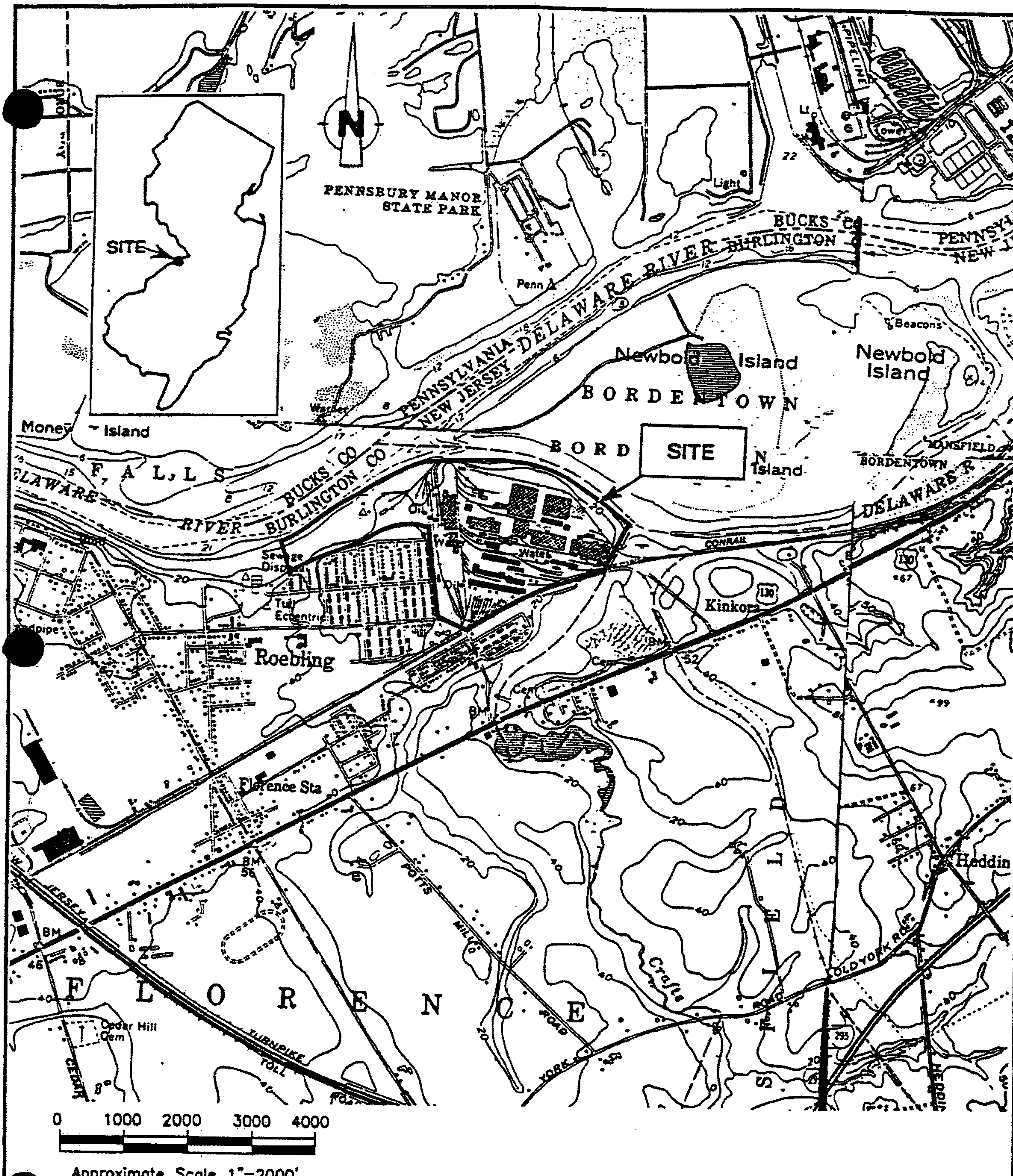
- Executive Summary, in which a brief summary of the FS Report is provided.
- Section 1.0, in which the scope of the FS is summarized and site features pertinent to OU-5 are described. Section 1.0 contains: a description of the site; a summary of the site history; and a summary of the RI Report.
- Section 2.0, the RAOs are presented in Section 2.0. Items which may require remediation and general response actions are identified. Potential remedial technologies, suitable for achieving remedial action objectives, are initially screened based on general applicability to site contaminants, media, and conditions. Finally, technologies are screened based on effectiveness, implementability, and cost criteria.
- In Section 3.0, remedial alternatives are developed and screened.
- Detailed evaluations of the alternatives developed in Section 3.0 are presented in Section 4.0. Each alternative is evaluated individually against seven of the nine evaluation criteria. Comparison of these alternatives to one another is also performed.
- References are cited in Section 5.0.

1.2 SITE LOCATION AND DESCRIPTION

1.2.1 Site Location

The RSC is located on over 200 acres in Florence Township, Burlington County, New Jersey, in the vicinity of 40° 07' 25" north latitude and 74° 46' 30" west longitude. The site is located on the Bristol, PA 7.5 minute United States Geological Survey (USGS) topographic quadrangle map.

The site property is located at Second Avenue and Hornberger Avenue, in the Roebling section of Florence Township. As shown in Figure 1-1, the site is bounded on the north and east by the Delaware River and Crafts Creek, respectively. The Village of Roebling is located to the west and south of the site property. U.S. Route 130 is approximately one-half mile south of the site property.



SOURCE:

USGS TOPOGRAPHIC 7 1/2 MINUTE SERIES QUADRANGLES
TRENTON WEST, NJ, BRISTOL, PA; TRENTON EAST, NJ; TRENTON WEST, NJ

FIG1-1

U.S. ENVIRONMENTAL PROTECTION AGENCY

Roebling Steel Company Site

FIGURE-1-1

SITE LOCATION MAP

FOSTER WHEELER ENVIRONMENTAL CORPORATION

1.2.2 Site Description

The site has primarily been used since 1906 for production of steel products, but has also partially and intermittently been used in more recent years for various industrial operations. There were over 70 on-site buildings which occupied most of the site property, connected by a series of paved and unpaved access roads. Figure 1-2 illustrates the site layout.

West and southwest of the site property, residential housing areas predominate. Most residential development adjacent to the site was constructed by the steel plant operators and used to house plant employees. The nearest residential dwellings to the site are approximately 100 feet from property boundaries. A Penn Central (Conrail) track runs to the southeast of the site. Areas on either side of this track are zoned for special manufacturing activities.

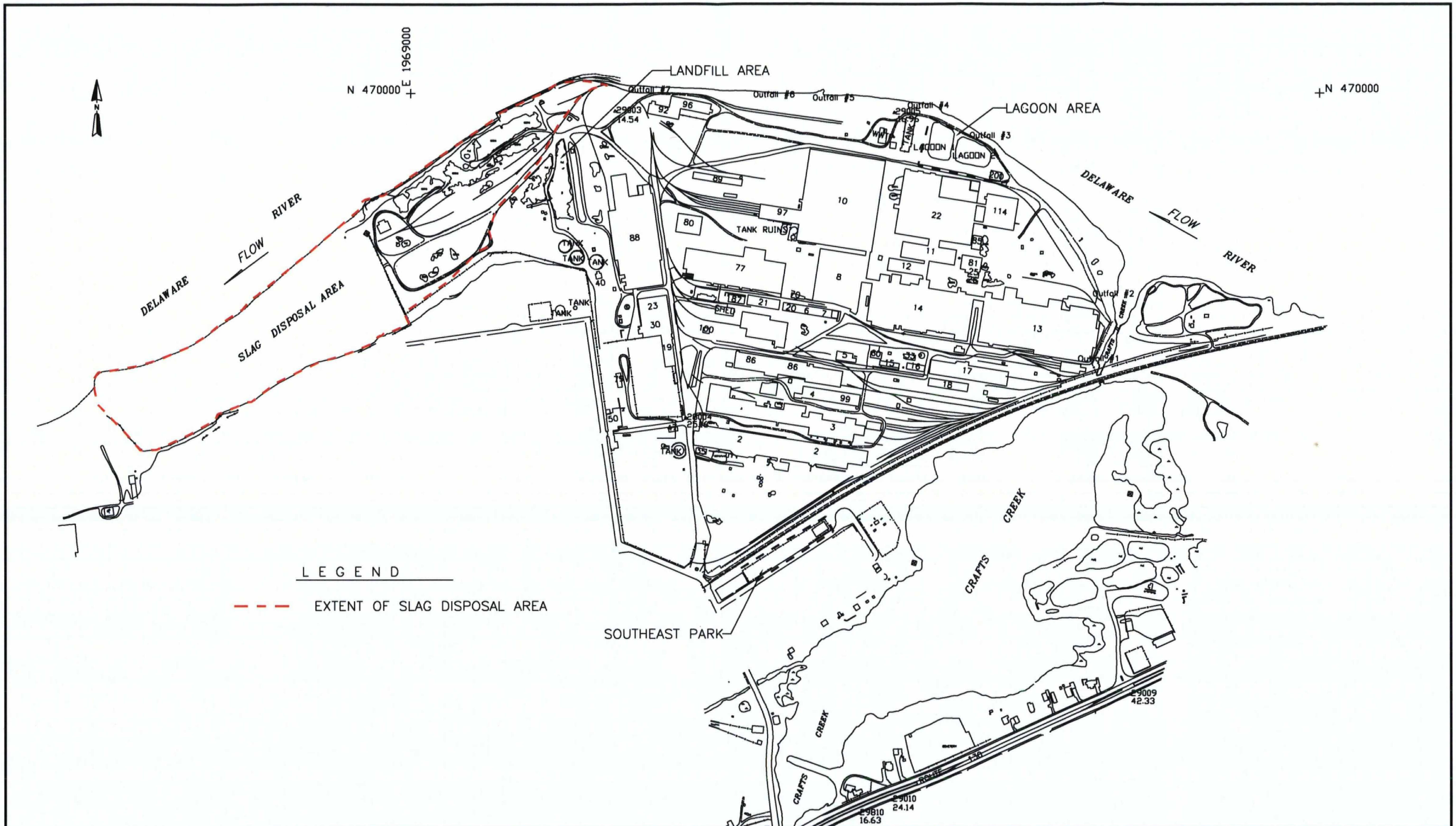
Newbold Island (New Jersey) lies in the Delaware River immediately north of the site (Figure 1-1). This island, owned by Public Service Electric and Gas Company, covers an area of approximately 500 acres and is largely undeveloped. The City of Burlington, located approximately six miles downstream from the site, uses the Delaware River for its water supply. The City obtains water both directly from the Delaware River and indirectly through shallow wells located on Burlington Island, located southwest of the RSC. The Delaware River also supplies water to the City of Philadelphia, farther downstream.

1.3 SITE HISTORY

1.3.1 Historical Site Use

A more complete discussion regarding the site history is provided in the Final Remedial Investigation Report for OU-5 (FWENC, 2002). The components of that discussion pertinent to the FS for OU-5 are summarized in this section.

The Roebling Steel plant had its inception in the year 1841, in the small town of Saxonburg, Pennsylvania, where John A. Roebling, a young expatriot German engineer, developed the world's first practical wire rope. Wire rope's most lasting contributions came first in suspension aqueducts across rivers, and then in the famous suspension bridges. Roebling moved his operations to Trenton, New Jersey in 1848. About the turn of the century, the John A. Roebling's Sons Company had grown to such proportions that extensive additional facilities were needed. After many considerations, a site was selected on the Delaware River, 12 miles south of Trenton. The plant area was initially called Kinkora and it later became known as Roebling. Construction of the plant at Roebling began in 1904 and operations began in 1906 (Roebling, undated) (Book 20, Undated). To expand the plant, areas were filled toward the Delaware River to the north with slag, cinders, and other materials (Lovelett, 1992). The site remained in the family until 1952 when it was sold to the Colorado Fuel and Iron Company (CF&I). Equipment in the Roebling facility was updated in the 1960s, and included installing electric arc furnaces to improve efficiency in melting steel. During this period, marketing efforts at the Roebling facility were concentrated in the high carbon wire segment of the wire industry in order to utilize the new melt furnaces and the Blooming Mill, Billet Mill, and Rod Mills. The firm withdrew from the suspension bridge construction market and terminated nonferrous wire production.



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U.S. ENVIRONMENTAL PROTECTION AGENCY
Roebling Steel Company Site

Figure 1-2
Site Layout

FOSTER WHEELER ENVIRONMENTAL CORPORATION

The Crane Company acquired the CF&I holdings, including Roebling, in the late 1960s and began a shutdown of CF&I's unprofitable production facilities (Roebling, Undated). During Crane's ownership, Roebling remained profitable and plans were initiated for a major capital improvement program, including the construction of a wastewater treatment facility capable of purifying 10 million gallons of water per day. It was completed in 1973 at cost of about $3.2 million. A new air pollution control installation was purchased and installed in 1974 at a cost of approximately $1.5 million. A new Morgan "No Twist" rod mill was purchased and its installation was started, but the project was subsequently discontinued (Roebling, Undated).

By the early 1970s, the Roebling facility's financial strength declined as it was burdened by the huge pension liabilities transferred from other plants that Crane Company had closed (Roebling, Undated).

CF&I operated the facilities as its John A. Roebling's Sons division until its sale in June 1974 to the Alpert Brothers Leasing Company (ABLC). ABLC formed the Roebling Steel and Wire Corporation and operated the facilities until May 1979. In May 1979, the John A. Roebling Steel Company (JARSCO) was formed through financial assistance provided by the U.S. Economic Development Administration, the New Jersey Economic Development Authority, and private funds. JARSCO ceased operations in June 1981 and leased portions of the site property. An unrelated corporation (i.e., not engaged in wire production), the Roebling Wire Company (RWC), began operating on a leased portion of the site in January 1982. RWC closed their operations from June 30 to July 28, 1983, then filed a Chapter XI petition for bankruptcy and continued to occupy the site premises until October 1985, when RWC informed the New Jersey Department of Environmental Protection (NJDEP) that it had ceased operations at the RSC and did not intend to resume them at that location. In addition to the aforementioned companies, there were various tenants to whom portions of the site were reportedly leased.

The following subsections contain discussions of the primary processes and operations which took place at the RSC. Included are site-specific information, as well as general summaries of the various processes. Primary references include: The Making, Shaping and Treating of Steel-Eighth Edition, United States Steel, 1964 (USS, 1964); various documents copied from the RSC files; and legal depositions of former plant employees. The following discussions are detailed because the significant magnitude and diversity of site operations has resulted in widespread environmental contamination. The RSC has been called a "megasite" relative to most other Superfund sites.

Steel Ingot Production (Melt Shop [Building 2] Operations)

Originally, both basic and acid steel were produced at Roebling in nine open-hearth furnaces (capacities of 40 tons each except for one, which had a capacity of 80 tons) (Lovelett, 1992). In 1964 - 1965, three electric arc furnaces were installed to replace the open hearth units.

During open hearth steel making operations, both pig iron (from iron ore produced by off-site blast furnace operations) and scrap iron were used as furnace raw materials (or charge). The electric furnaces were fed scrap iron exclusively. Both purchased and home (on-site produced) scrap were used.

With the exception of one source of pressed and sheared auto bodies, all purchased scrap was delivered by rail. Wherever possible, incoming inspected and approved cars were directly loaded into charging buckets, or into storage bins in the Melt Shop. Cars not handled in this manner were unloaded into segregated piles in the Scrap Yard (Book 20, Undated).

Other raw materials were used in the Melt Shop for addition or removal of carbon, and for alloying and deoxidation purposes. Major categories were:

- Ferro-alloys (deoxidation and alloying), containing silicon or manganese;
- Pure metals (deoxidation and grain refinement), including aluminum;
- Carbon (addition of carbon), including anthracite coal or graphite; and
- Oxygen (removal of carbon), either as a gas or as oxidized metal.

Other elements that were added at times to produce special alloy steels were nickel and chromium (Lovelett, 1992). Limestone, raw or unburnt, was added to the charge to form a slag layer on top of the bath, which acted to remove impurities such as phosphorus and sulphur. Other non-volatile impurities present in the scrap charge were also contained by the slag layer. Fluidity of the slag was controlled by the addition of fluorspar (Book 20, Undated).

Blooming Mill Operation (Building 3)

In the Blooming Mill, the ingots were reduced to either 4-inch x 4-inch or 2-inch x 2-inch billets. The stripped ingots were brought to a rolling temperature of 2,000°F to 2,100°F in preheating furnaces and soaking pits in the east end of the Blooming Mill. Rolling was a kneading of the steel while it was hot enough to be deformed by large power driven steel rollers that squeezed it from 15" x 15" to 2-5/16" x 2-5/16" billets. The steel structure was reformed by this hot working process. The surface was improved, as was the internal condition, resulting in a better steel bar. Billets were cooled, inspected, and surface defects were removed. They were stored outdoors in a billet storage yard until scheduled to be rolled into rod.

Rod Mills (Buildings 78 and 86)

Billets from the Blooming Mill were converted into both flat and round rods in the Rod Mills at the RSC. Billets were heated from outdoor temperature to 1,850-1,950°F for rolling in a 12 to 20 pass continuous three strand mill. Round rod sizes ranged from 0.218" to 0.490" diameter and flat rods required a variety of special sizes. The rods were wound into coils of approximately 3-foot diameter while they were still red hot. They were then cooled, inspected, and tied into bundles for shipment to the wire mills or customers. While the rod represented the finished product of the rolling mills, it constituted the raw material for the wire mills (Book 20, Undated).

Patenting (Building 10)

Patenting was the first operation in the normal processing of a high-carbon rod into wire. Patenting was a continuous strand process, which consisted of heating the rods to a predetermined temperature above the critical temperature, followed by cooling through the critical range at a rapid rate. The rods were heated in a muffle-type furnace and then quenched in air or molten lead. This developed a

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structure in the steel that was uniform and tough, and the steel possessed good wire drawing properties (Book 20, Undated). Wire patenting was also performed in Building 13 (Lovelett, 1992).

Cleaning (Buildings 10, 28 and 85)

Most high-carbon rods were patented prior to cleaning, but low-carbon and some high-carbon rods were cleaned in the first operation. Normally, cleaning was accomplished by immersion in hot dilute sulphuric acid, but in special cases hydrochloric acid was used. The acid in the tank was heated by live steam, and the temperature and concentration of the solution were controlled within certain limits to obtain proper results.

The rods were picked up in the temporary storage area and transported to the beginning of the cleaning line, where the load was placed on specially constructed pins that were picked up by gantry-type cranes and transported through the operation. Rods were immersed in the hot acid for a specified period of time and then rinsed in water. They were then processed through the various types of coating tanks for the application of lime, borax, or zinc phosphate to neutralize all remaining acid and to provide a carrier for the lubricants used in the wire drawing die boxes. After coatings were applied, the rods were placed in the flash bakers to dry. Upon completion of the cycle of cleaning, coating, and drying, the loads of material were deposited at the end of the line by the crane. Ram tractors transported the rods to the wire drawing machines for further processing (Book 20, Undated).

Wire Mills (Buildings 13, 14, 22, 77 and 114)

The Wire Mills processed steel rods into round and shaped wire of many grades, finishes, and specifications. Some of the many products that were produced were: rope wire, bridge wire, spring wire, tire bead wire, hose wire, field strand wire, concrete strand, pipe mesh, and a variety of specialty items. Rods were received from the Rod Mills in gondola cars, which were spotted in the storage area of the Patenting Shop. The rods were unloaded with hairpin hooks suspended from a bridge crane and placed in storage. Ram tractors were used to distribute the rods from storage areas to the subsequent operations.

The focal point of the Wire Mills was the wire drawing operation. Wire drawing consisted of pointing a rod, inserting it in a tungsten carbide die, attaching it to a capstan, and pulling onto that capstan. The hole in the die was a predetermined percentage smaller than the rod. Once the rod passed through the first hole it became wire, and each hole thereafter increased the tensile strength as it decreased the diameter of the wire. Wire drawing was performed on a machine that consisted of one or more dies and a corresponding number of capstans. Motor driven capstans provided the power to pull the wire through the dies at successively higher speeds. The machines were equipped with various means to handle the finished wire, i.e., into coils, onto dead blocks, onto reels, or into cores. Some of the fine wire machines were equipped for wet drawing, which is similar to dry drawing, except that the capstans and dies were enclosed to contain the liquid lubricant. It was also possible on these machines to provide a variety of coatings such as copper, straw, brass, liquor, etc., in accordance with customer demands.

To facilitate the production of copper or bronze plated wire, there were two units that incorporated the processes of heat treating, cleaning, plating, coating, straightening, and reeling into one continuous operation. At these rigs, reels of wire were placed in the pay-off stand and the wire was run through: a lead furnace to relieve stress, acid tubs and water rinses to remove lead and other impurities, a plating bath, a dryer, a coating tank, straighteners, and onto the finishing reel. The primary product from this operation was tire bead wire (Book 20, Undated). During the period of approximately 1965 until 1970, a cadmium plating operation also took place at the site (Lovelett, 1992).

Tempering

Another finish applied to wire manufactured at the Roebling plant was oil tempering. Oil tempered wire furnished a high elastic limit tensile strength ratio material used to manufacture parts that would not be hardened after forming. In continuous strand hardening and tempering, the wire was successively heated to a predetermined hardening temperature, quenched immediately in oil, and tempered in molten lead. The wire from the oil tempering furnaces was either ready for shipment in coils or reels, or it was sent to machines which straightened, measured, and cut the wire to specified lengths. After cutting, this wire was placed in specially designed skids and packaged for shipment.

Welded Fabric (Building 88-Subsequent to Copper Mill Operations)

In addition to the previous functions, wire was also drawn for processing into welded wire fabric for pipe mesh. This wire was normally drawn from low carbon rods and was generally considered coarse wire. Welded fabric consisted of a series of longitudinal and transversal wires welded together at all points of intersection by a process of electrical-resistance spot welding.

The machine consisted of a battery of straightening rolls for longitudinal wire, a single feed roll for transverse wires, a battery of welding "heads," a pull-out drum or table, and a take-up baler. The take-up baler was used in the production of welded fabric. When sheets were desired, the fabric was passed through a shear and cut to specified lengths.

Galvanizing (Building 8)

In order to make corrosion resistant wire, the steel was galvanized or coated with a layer of zinc. Coils of wire were placed on the pay-off swifts with the aid of electric hoists, and the wire was run through a molten lead pan to heat the wire and burn off any drawing lubricants that might adhere to the wire surface. The wire was then pulled through a water quench, an acid (hydrochloric) bath, then a second water tank to remove the acid. The wire then passed through a flux solution containing zinc ammonium chloride, which prepared the surface of the wire to assure bonding of the molten zinc to the wire. The wire then entered the zinc pan, passed through charcoal wipers, over a cooling tower, and onto horizontal take-up blocks. Some wire was drawn further after galvanizing, and this wire had both corrosion resistance and a bright finish (Book 20, Undated). Wire was sometimes coated with cadmium instead of zinc (Lovelett, 1992).

Copper Wire Production (Building 88)

Complete facilities for the cleaning, drawing, annealing (a heat treatment process similar to patenting), and fabrication of copper wire into strand or rope were located in the Copper Mill.

Underground Storage Tanks (USTs)

There were nine USTs located outside of buildings at the RSC. These USTs were located: between Buildings 15 and 16 (one tank), southwest of Building 31 (one tank), west of Building 12 (two tanks), west of Building 31 (one tank), east of Building 19 (one tank), west of Building 30 (one tank), between Buildings 8 and 14 (one tank), and north of Building 10 (one tank).

Process Waste Treatment/Disposal

Liquid Wastes

During the operations at the RSC, large volumes of contaminated wastewaters were generated, treated to various degrees, and discharged to the Delaware River and Crafts Creek. All of the wire was cleaned with muriatic or sulfuric acid to remove scale. The cleaning operations resulted in acid wastes that entered the sewer system mixed with varying amounts of water. The principal acid contamination was caused by dumping spent acid tubs situated in the cleaning departments. A lesser amount of contamination occurred from the water used for final rinsing of the wire to remove the cleaning liquor.

Large volumes of surface water and groundwater were available for plant operations. The main intake point for surface water from the Delaware River was at Building 91-River Water Works (a.k.a. Building 119). There were four 1,500 gallons per minute (gpm) pumps located in this building. A surface water/groundwater extraction point was located at Building 70-Well House, west of Building 8. A 1938 plant survey map shows a 5-foot high underground passageway, which connected this well with the Delaware River. Building 70 could not be found during the RI field investigation. The RSC files contained an untitled and undated list of plant uses for surface water and municipal water, as follows.

Surface water was used in the following:

Melt Shop - The water flowed through closed heat exchangers (water cooled elbows, electrode coolers, etc.) and was discharged through Outfall #001. It picked up no contamination.

Blooming Mill - The water splash cooled the 35-inch and 18-inch hot rolling mills and flowed to the treatment plant. The water picked up iron contamination and some oil.

Boiler House - The water was turned to steam, used both for heating and to drive a steam engine, then condensed in a barometric condenser and flowed to the treatment plant. The water picked up some oil contamination.

Rod Mill - The water flowed through closed heat exchangers to cool the furnace, then flowed to the treatment plant. There was no contamination picked up. In the roughing, intermediate, and finishing mills, water from splash cooling operations flowed to the treatment plant. The water picked up oil and iron contamination.

Wire Mills - The water was used in the rinse baths, as well as for spray and contact cooling, and flowed to the treatment plant. The water picked up iron, zinc, lead, sulfate, and soap contamination.

Tempering Shop - The water was used in the rinse bath, as well as for spray cooling and contact cooling of the meaker rig and 11 tempering rigs. The straight line cleaning house used water for acid rinse washing. The water discharged to the treatment plant, and picked up iron, lead, sulfate, chloride, phosphate, and spent pickle acid contaminants.

Cold Rolling Mills - The cooling and rinse baths used water which flowed to the treatment plant, and picked up iron contamination.

Annealing House Heat Exchanger - This equipment had a once-through flow of water in a closed heat exchanger, which flowed to the treatment plant, but did not pick up any contamination.

Machine and Blacksmith Shops - These shops used water for cooling which flowed to the treatment plant, but did not pick up any contamination.

Municipal water was used in the following:

Cable Cooling - Water flowed through a heat exchanger only before flowing to Outfall #001. It did not pick up any contamination.

No. 1 Wire Mill - Machines had a closed loop heat exchanger for cooling, and the water flowed to the treatment plant. There was no contamination.

Cold Rolling Mills - All equipment had heat exchangers cooled by water, and the water flowed to the treatment plant. There was no contamination.

Solid Wastes

Relatively few references to solid waste disposal practices were found in the Roebling files. It is apparent that the Slag Disposal Area was used primarily for the disposal of slag. Crushed skulls (hardened material built up in ladles) were also likely disposed in the Slag Disposal Area. Materials disposed in the landfill included spent refractory brick, baghouse dust, well scale, furnace scale, decommissioned process equipment, wood, office waste, rags, and miscellaneous non-combustible materials. Baghouse dust, which currently is a listed hazardous waste, was disposed in the landfill during the last one (1974) to two years of CF&I's operations (Lovelett, 1992).

In a Roebling plant memorandum dated April 7, 1965, the quantities of lead used at the site were documented. For the entire year (1964), the following quantities of lead were used:

- Patenting Shop (Building 10) — 946,675 pounds
- Galvanizing Shop (Building 8) — 250,359 pounds
- Wire Mill No. 2 (Building 13) — 525,920 pounds

No indications regarding the ultimate disposition for this lead were provided; however, it is likely that large quantities of the lead were removed as dross, accumulated in drones and sold to off-site smelters, as well as lost to the atmosphere as volatilized gases (Lovelett, 1992).

Air Wastes

Various levels of air pollution control were implemented at the RSC over the years of operation. No dust control system was used during the operation of the open hearth furnaces. Dust would be released within the building and directly out the stacks. Dust control facilities for the electric arc furnaces were in use as early as 1968. This system was upgraded in 1973 with a new second dust control facility, which was subsequently completely removed from the site (Lovelett, 1992).

1.3.2 <u>Remedial Actions To Date</u>

Removal Actions

Four removal actions were performed at the RSC. In December 1985, NJDEP removed picric acid and other explosive chemicals from one of the on-site laboratories and detonated them at the Earle Naval Weapons Station. The USEPA performed the other removal action between October 1987 and November 1988. Following is a summary of the removal action activities:

- Approximately 300 lab pack containers of chemicals were collected, removed, and disposed off-site. The chemicals included acids, bases, inorganic salts, alcohols, and other halogenated organic compounds. Laboratory chemicals were removed from Buildings 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 25, 26, 30, 31, 59, 60, 64, 72, 78, 79, 81, 86, 87, 88, 91, 92, 93, 94, 99, and 114.

- Three thousand two hundred and three (3,203) 55-gallon drums (2,004 full; 1,199 empty) were sampled and disposed at Resource Conservation and Recovery Act (RCRA)-permitted facilities. Drums were recovered from Buildings 2, 3, 5, 8, 10, 11, 12, 13, 14, 25, 26, 64, 81, 93, and 114.

- One hundred twenty (120) cubic yards of emptied drums were crushed and removed to a USEPA-approved hazardous waste landfill in Indiana.

- Three pounds of metallic mercury were collected, repackaged, and sent to an off-site recycling facility for distillation and reuse.

- Thirty-seven (37) tons of baghouse dust near the southern border of the site were contained and secured with tarps and barriers.

- One drum of hazardous waste containing cyanide was shipped to an approved treatment facility.

- Forty (40) compressed gas cylinders containing flammable gases, oxidizers, corrosives, poisons, and other gases were returned to manufacturers or other facilities for reuse and recycling. Several cylinders were detonated on-site.

- Approximately 3,000 gallons of sulfuric acid and 2,150 gallons of phosphoric acid were sampled, analyzed, and removed from the two large, aboveground tanks adjacent to Building 12 and sent to an off-site facility for reuse.

- Two hundred thirty-nine thousand (239,000) pounds of hazardous solids in drums were bulk packed into roll-off containers and shipped to an off-site RCRA permitted facility.

- Exposed asbestos in potential personnel-entry zones was wrapped and contained.

USEPA conducted another removal action in October 1990, that included fencing a portion of the Slag Disposal Area and excavating contaminated soil from the Northwest Park.

In October 1998, USEPA began a site-wide removal action for asbestos mitigation from approximately 70 abandoned buildings and exterior piping located throughout the site. Approximately 91,592 linear feet of asbestos covered piping were abated. The asbestos mitigation was completed in November 1999.

OU-1 Items

The first operable unit consisted of on-site items which posed a sufficiently imminent hazard and were not addressed in the previous removal actions. These items included: remaining drums, nine exterior tanks, transformers, a Bag House dust pile, chemical piles, tires, and soil under the water tower in the Roebling Park. The ROD for OU-1 was signed on March 29, 1990, and specified off-site disposal for all OU-1 items. The design/remedial action was subsequently performed, with the final inspection occurring on September 11, 1991. Following is a summary of the OU-1 remediation:

- Approximately 582 drums were removed as part of the remediation. The 582 drums included approximately 104 empty drums without lids and approximately 239 drums without lids that contained either trash, debris, or oil. Most of the drums were located in Buildings 4, 16, 17, 18, 22, 23, 30, 31, 77, 78, 86, 88, 89, 92, 96, and 99.

- The exterior tanks addressed by the OU-1 remediation were seven petroleum storage tanks (T-2, T-3, T-4, T-6, T-28, T-29, and T-99) and two tanker cars (T-16 and T-30).

- Approximately 220 transformers were removed during the OU-1 remediation, including 33 transformers from the substation adjacent to the Southeast Playground. The on-site building numbers and associated number of liquid-cooled transformers in parentheses are as follows: 2(8), 3(9), 6(6), 7(7), 10(7), 13(15), 14(29), 17(1), 19(2), 21(1), 22(1), 23(1), 60(1), 77(1), 78(3), 79(9), 80(1), 86(9), 87(21), 88(41), 92(2), 99(2), 114(2), and 115(8).

- Approximately 778 tons of baghouse dust were removed from the covered area on the west side of Building 88. The baghouse dust was a potential source for leaching of chromium, lead, and cadmium. Baghouse dust is also a RCRA listed waste.

- A total of 74 chemical piles were remediated in 10 buildings. The building numbers and associated number of chemical piles in parentheses are as follows: 2(38), 3(15), 4(1), 8(4), 10(5), 13(3), 15(2), 86(1), 99(4), and 103(1). The chemical piles located on floors were removed using heavy equipment. The chemical piles located in bins or process troughs were removed by shoveling the material into containers. Only loose materials were removed from the chemical piles inside furnaces or under process equipment.

- The majority of used tires were located in and around Buildings 18 and 70. Other tires were scattered around the landfill area near Building 88. A total of 261 tons of whole tires and 188 tons of burnt tire material were removed from the site.

- Approximately 120 cubic yards (cy) of surface soil under the water tower in the Roebling Park, which was contaminated with elevated levels of lead, were removed as part of a removal action.

OU-2 Southeast Park

The OU-2 ROD for the RSC involved removal of contaminated soil in the Southeast Park. This completed remedial action included:

- Excavation of approximately 140 cy of contaminated soil located in three areas of the park for off-site disposal; and

- Backfill of the excavated area with clean soil and revegetation.

Soil samples from the Southeast Park exhibited low levels of volatile and semi-volatile organic contaminants, except for total polynuclear aromatic hydrocarbons (PAHs) in two sample locations. Also, inorganic contaminants were detected in the park soil at low concentrations, except for chromium, lead, and zinc at one sample location.

OU-3 Slag Area

The OU-3 ROD for the RSC addressed the 34-acre Slag Disposal Area along the Delaware River.

Over half of the property was created by filling in the Delaware River with process slag, cinders, and other fill material. The land was purchased, and riparian rights to fill in the river were obtained, so that, as the plant required additional structures, there would be enough room for expansion. Over time, buildings were constructed as needed, many on the slag fill. The surficial extent of the Slag Disposal Area designated as OU-3 is approximately 34 acres. It ranges in thickness from several inches to 30 feet, with the thickest deposits generally located adjacent to the Delaware River along the site's northwestern edge. The estimated volume of slag material in the 34 acres is approximately 710,000 cy. The slag material consists of very coarse soils composed primarily of residues from the high temperature processing of iron ore. In some locations, there are large blocks of slag material resting on top of the surface fill. The slag fill is believed to contain numerous fissures and voids, due to the very coarse nature of the slag, that allows water infiltration.

As part of the 1990 ROD, USEPA selected a remedy for the 34-acre Slag Disposal Area, which include treating hot spots of contamination, defined as highly contaminated slag material that fails a Toxicity Characteristic Leaching Procedure (TCLP) test, and then covering the entire 34-acre Slag Disposal Area with a soil cover and vegetation, a stormwater management system, shoreline protection, and institutional controls. The treatment component in the selected remedy was based on assumptions of the groundwater quality underlying the Slag Disposal Area, which were derived from limited groundwater data in the Slag Disposal Area and an extensive groundwater study of the remaining portion (i.e., the plant area) of the RSC. Prior to the Pre-Design Investigation, as documented in the ROD, only a total of 30,000 cy of materials were estimated to require treatment. In addition, the estimated volume requiring treatment was based on a limited number of samples analyzed for Extraction Procedure (EP) Toxicity and TCLP tests; therefore, it was anticipated that additional surface and subsurface sampling to further delineate hot spot areas would be necessary during the remedial design.

The United States Army Corps of Engineers (USACE) completed a Pre-Design Investigation in May 1999, which presents the analytical results of soil hot spot delineation, groundwater, surface water, sediment, and biota sampling of the Slag Disposal Area. The OU-3 Pre-Design Investigation resulted in the re-evaluation of remedial alternatives. The USACE completed the 95 percent design for the Slag Disposal Area in July 1997. The volume of slag material estimated to be contained within the 34-acre Slag Disposal Area is approximately 710,000 cy, with 210,000 cy exceeding the TCLP criteria. The spatial area associated with the hot spot zones is approximately eight acres. Although the Pre-Design Investigation Report (PIR) stated that the extent of the Slag Disposal Area was 34 acres at an average depth of 13 feet (i.e. 710,000 cy volume), the URS Report (Jacobi, 1996) stated a slag volume in excess of 1,000,000 cy. The reason for this higher value is that there was previously no distinction between slag material located in OU-3 and OU-5. For the purpose of this RSC FS, the slag material was divided into the 710,000 cy located in OU-3, with the balance being included with the soil volume for OU-5. The design report will be finalized upon completion of the OU-5 RI/FS, as it relates to the potential impact of the slag material on the surface and groundwater.

OU-4 Buildings, Equipment, Tanks, Pits, Piping Systems

The OU-4 ROD was signed in September 1996. It focused on the remediation of 70 abandoned buildings that contain contaminated process dust on the walls and floors, contaminated residue and materials in or on process equipment, tanks, pits, sumps, underground piping systems, and damaged friable asbestos.

The remedial approach involved separating the abandoned buildings into three groups based on the extent of contamination and the structural stability of the buildings. The groups were defined as follows:

Building Group A: Contaminated buildings that are structurally unsound.

Building Group B: Contaminated buildings that are structurally sound.

Building Group C: Buildings with no significant chemical contamination.

The reuse potentials for individual buildings were also assessed based on current structural conditions, building sizes and configurations, specific locations of buildings on the site, and other considerations. Contaminated buildings were segregated into two groups (A and B) to facilitate the development of a variety of decontamination/demolition alternatives. Group A buildings would have limited or no reuse potential due to lack of structural soundness, and high levels of contamination that would be infeasible to decontaminate. The most logical method to address the risks posed by contamination in these buildings would be to perform decontamination to minimum levels required for demolition, followed by demolition. For Group B buildings, it would be feasible to address the contamination risks by decontamination to specific risk-based cleanup standards.

The components of the remedial alternative selected in the ROD include the closure of USTs, removal of the contents from underground piping for off-site disposal, asbestos abatement, demolition of buildings in Group A, and decontamination of the buildings in Group B. Non-hazardous building demolition debris would be managed on-site. Scrap metal from building debris and contaminated equipment would be decontaminated and sent off-site for metal recycling or landfill disposal. Process dust and the contents of aboveground tanks and pits/sumps would be disposed off-site. Demolition debris that exceeds regulatory levels would be sent off-site for disposal.

The USACE initiated remedial design (RD) activities in June 1997, which have been separated into the following components: asbestos removal, building demolition, building decontamination, and remediation of the Main Gate House. The building demolition component of the RD was completed in March 1999, and the 95 percent design for the Main Gate House was completed in August 1999. The USACE continues work on the RD for building decontamination of certain buildings and cultural resources-related work.

The USEPA Removal Action Branch (RAB) initiated a site-wide asbestos removal in October 1998 in order to expedite the cleanup of buildings, which was completed in November 1999. As with the asbestos removal, the RAB is performing the demolition work in order to continue the remediation in an expeditious manner. Construction activities associated with the buildings started in July 1999. Site work completed thus far includes demolition of 25 buildings, and mitigation of 11 underground storage tanks and four aboveground oil storage tanks. Site work continues on gross decontamination of 16 buildings, removal of underground oil transport lines and chemical lines, segregating demolition debris, recycling steel debris, and disposal of all wastes generated as a result of construction activities. This remedial action is still ongoing and the volumes of soil managed under OU-4 can be found in the USEPA Pollution Reports, which are updated weekly.

1.3.3 Current Conditions

The site is presently inactive and under the control of the USEPA, which maintains a continuous on-site security force. The security force is stationed at the south entrance of the site, at the intersection of Second Avenue and Hornberger Avenue. Although there is a 24-hour security force on-site, the site property can be accessed from its north, west, and east sides, i.e., along the Delaware River. The USEPA has posted signs indicating that the site is hazardous. Buildings at the facility have been abandoned for a number of years, leading to significant deterioration in many of the structures.

1.4 REMEDIAL INVESTIGATION REPORT SUMMARY

1.4.1 Environmental Setting

Geologic Characteristics

The RSC is underlain by a sequence of fill materials, sands, clays, silts, and gravels. These deposits, excluding the fill material, appear to correlate to the Raritan or Magothy Formations of the Cretaceous Age, which outcrop along the eastern bank of the Delaware River throughout much of southern New Jersey. These two formations contain major aquifers of the Atlantic Coastal Plain in New Jersey.

The sediment and fill material penetrated by borings at the RSC have been divided into five major correlative stratigraphic units, with each unit described below. Figures 3-5 to 3-5a and 3-6 to 3-10, provided in the March 2002 Final RI Report prepared by FWENC for OU-5 of the RSC, display the site stratigraphy based on information obtained from RI-related field investigations.

Fill

This material, though not naturally deposited, is horizontally and, in many cases, vertically extensive. The Fill unit is composed of material that includes hardened slag, black sand-sized particles (possibly fly ash and/or cinders), construction debris, and soil. The soil fill consists predominantly of a brown, coarse to fine-grained sand, with lesser amounts of gravel, silt, and brick materials. The surficial Fill unit is present across most of the site. Its thickness ranges from several inches to nearly 30 feet, with the thickest deposits generally located adjacent to the Delaware River along the northern perimeter of the site.

Upper Sand

The Upper Sand unit is composed of a poorly-sorted material consisting primarily of a coarse to fine-grained sand, with appreciable amounts of finer and coarser grained constituents. The color of this unit varies significantly, ranging from a dark gray to a yellowish-brown. Contained within this correlative unit are laterally-discontinuous layers of gravels, silts, and organic-rich clays. The Upper Sand unit has been encountered across the entire site, with the exception of the western Slag Disposal Area. It appears the Upper Sand unit in the Slag Disposal Area had been eroded away by the Delaware River, and was subsequently filled in with slag materials by the former site owners. Typically, the Upper Sand unit is found underlying the Fill unit, and above either the Upper Clay unit or the Lower Sand unit (described below). The thickness of the Upper Sand unit ranges from about 7 feet to 38.5 feet.

Upper Clay

Based on field interpretation of recovered material from split-spoon sampling, the Upper Clay unit consists primarily of a low to medium-plasticity clay. The color and amount of coarser-grained material within this clay varies across the site. Based on site-wide stratigraphic correlations, the Upper Clay unit is not present in the western Slag Disposal Area and along the norther perimeter of the site. In these areas, the Fill unit and/or Upper Sand lies directly atop the Lower Sand unit. Where the

Upper Clay unit was encountered and fully penetrated, it ranged in thickness from 2 feet to as much as 21 feet.

Intermediate Sand

Based upon the lithologic log of monitoring well MW17D, an intermediate sand layer (15 feet thick) is present within the Upper Clay unit in this area. A sand layer at the same approximate depth interval is also present at monitoring well locations MW27 and MW28, near the Crafts Creek Channel. Based upon the lithologic data, it is not known if these two layers are continuous between MW17D and MW27/MW28. However, hydraulic monitoring data indicates that this layer is most likely isolated and not in hydraulic connection with the Lower Sand aquifer (i.e., minimal tidal influence was noted in this well).

Lower Sand

The Lower Sand unit is similar to the Upper Sand unit, composed predominantly of poorly-sorted fine-to-coarse grained sands, with a variable percentage of fines. However, the Lower Sand unit does not appear to contain the thin, laterally discontinuous, interlayers of coarser and finer lithologic subunits found in the Upper Sand unit across the site area. Where the Upper and Lower Sand units are in direct contact (Upper Clay absent), the transition is difficult to judge, and the two layers can be considered a single hydrogeologic unit. The Lower Sand unit was encountered throughout the site, ranging in thickness from 20 to 58 feet near the center of the site.

Lower Clay

Based on field interpretation of material recovered through split-spoon sampling, the Lower Clay unit consists of a low- to highly-plastic, gray to dark gray clay. This unit was found to contain appreciable amounts of fine sand and silts. The Lower Clay unit was encountered in six borings at the site, and at each location, was found underlying the Lower Sand unit.

Hydrogeologic Characteristics (Aquifers)

The hydrogeological investigation of the RSC was designed to obtain physical characteristics of the Upper and Lower Sand units, and determine the hydraulic connection between the two and the nearby Delaware River. This was achieved by an extensive groundwater level measurement program in on-site monitoring wells, including long-term water level monitoring to assess potential tidal effects on groundwater levels; analysis of subsurface soil samples for geotechnical parameters to help define the physical characteristics of the aquifer material; and aquifer testing in both the Upper and Lower Sand Aquifers.

Based on the differences between the potentiometric surfaces in the Upper and Lower Sand units, and variations between high and low tide measuring events, the following hydrologic observations can be made:

- The vertical groundwater flow gradient is consistently downward through the Upper Clay semi-confining unit across the site at both low tide and high tide. This downward flow gradient is consistent with the regional groundwater flow gradient.

- Where the semi-confined Upper Clay unit is not present (i.e., along the channel and in the western portion of the Slag Disposal Area), the potentiometric heads in wells completed in the Upper Sand unit are only slightly higher than heads in wells completed in the Lower Sand unit. At these locations, the Upper and Lower Sand Aquifers are hydraulically connected.

- At paired wells completed in the Upper and Lower Sand Aquifers not in proximity to the Delaware River, the potentiometric heads were found to fluctuate substantially such that the vertical gradient varied over time. This is due to the fact that the Lower Sand Aquifer is semi-confined, and the Upper Sand Aquifer is unconfined. The Lower Sand Aquifer's potentiometric daily head fluctuations are greater than in the Upper Sand Aquifer due to tidal elevation cycles in the Delaware River. Therefore, at high tide, an upward gradient from the Lower Sand Aquifer to the Upper Sand Aquifer may be present, and at low tide, a downward gradient from the Upper Sand Aquifer to the Lower Sand Aquifer may be present.

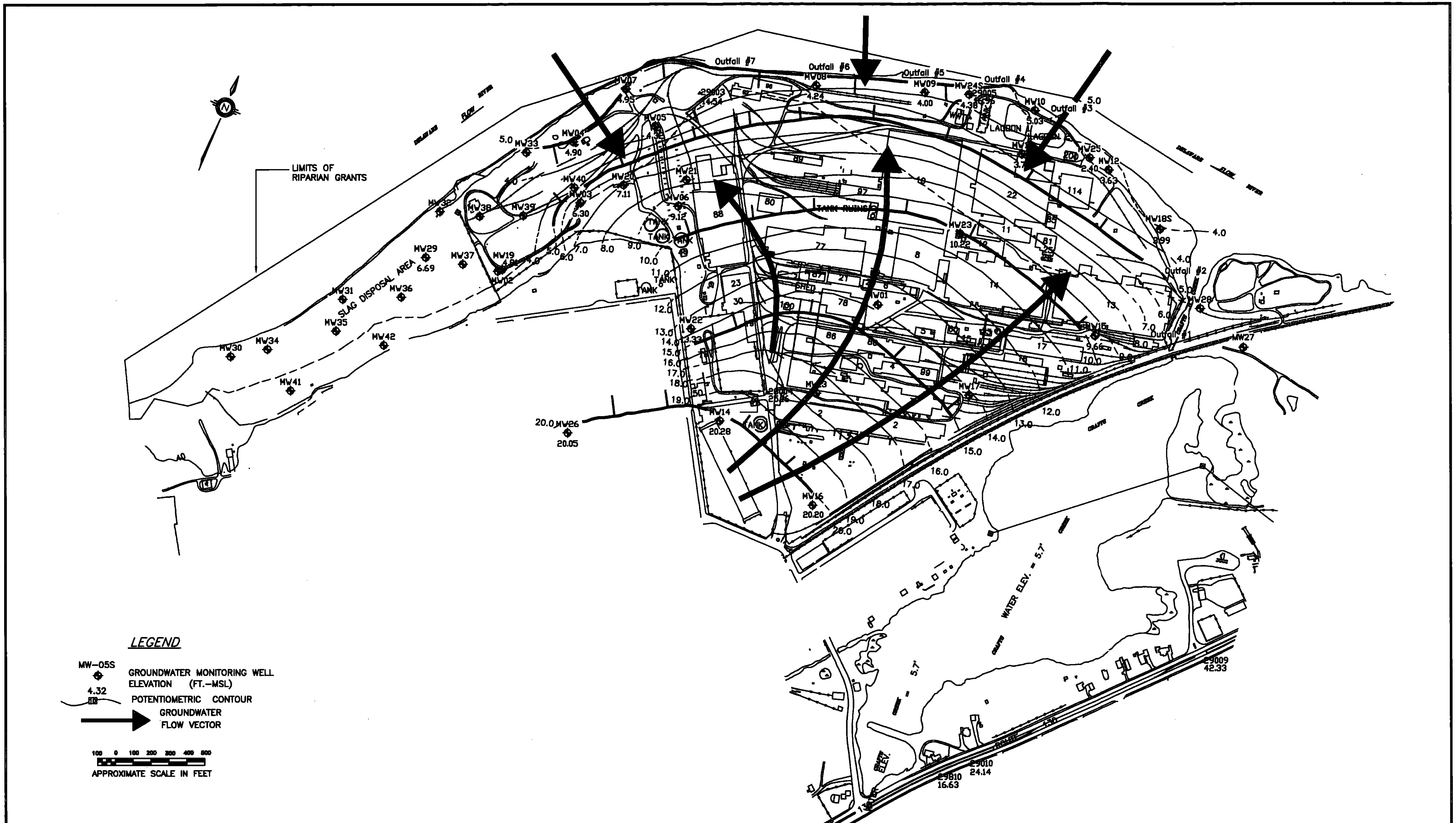
Review of potentiometric maps prepared for the RSC indicate the shallow Upper Sand unconfined aquifer is tidally influenced within approximately 150 to 200 feet of the Delaware River. The Lower Sand semi-confined aquifer is tidally influenced across the entire site, with water level variations due to tides decreasing away from the Delaware River. Since data are not currently available for the Lower Sand Aquifer, groundwater potentiometric surface figures for high and low tide are only available for the Upper Sand Aquifer, as presented in Figures 1-3 and 1-4.

Drainage and Surface Water

The RSC is bounded on the north by the Delaware River, and the east by Crafts Creek. Because of their proximity to the site, these two water bodies serve as receptors of point source and non-point source discharges from the facility. Most groundwater flow in the shallow water table aquifer at the site discharges north or northeast to the Main Channel and Back Channel of the Delaware River. Some shallow groundwater also discharges east to southeast to the Crafts Creek tidal channel/basin area in the southeast corner of the site.

Northeast of the site, the Delaware River is divided by Newbold Island into two channels, with the Main Channel located north of the island, and the Back Channel located south of the island. Immediately north of the site, the Main Channel has a width of approximately 1,300 feet. The USACE maintains a shipping channel (the Kinkora Range in this reach of the Delaware River) within the Main Channel. The shipping channel is approximately 600 feet wide, with a depth of 40 feet at Mean Lower Low Water (MLLW).

This reach of the Delaware River is subjected to tidal influence, with the tidal range measuring approximately 8 feet at the site. Based on USGS's observations at the Burlington-Bristol Bridge in 1955 to 1957, the tidal excursion ranged from 5.4 to 7.8 miles in the upstream direction and 7.6 to 9.1 miles in the downstream direction. The side channel south of Newbold Island is approximately 500 feet wide and is relatively shallow (from less than 3 feet to twelve feet) at MLLW. Crafts Creek



U.S. ENVIRONMENTAL PROTECTION AGENCY

Roebling Steel Company Site

Figure 1–3
Potentiometric Surface of Upper Sand Aquifer at High Tide, 5/3/90 (Feet AMSL)

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New FS High Tide 1-3.dwg

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Roebling Steel Company Site

Figure 1–4
Potentiometric Map of Upper Sand Aquifer at Low Tide, 5/3/90

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New FS Low Tide 1-4.dwg

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discharges into the southern channel of the Delaware River over a weir located at the mouth of the creek. Discharge to the Delaware River from Crafts Creek is controlled by river tidal conditions. During ebb tide conditions, flow is directed to the Delaware River; however, during high tide in the Delaware River, flow reversal occurs, with river water flooding back over the weir into Crafts Creek.

The Delaware River and its tributaries have a total drainage area of approximately 12,765 square miles. The drainage area of the Delaware River at Trenton is approximately 6,780 square miles. Delaware River flow has been measured by the USGS at Trenton since 1913. During this time, river flow at Trenton has averaged 11,670 cubic feet per second (cfs). Since 1955, low flows in the Delaware River have been augmented by upstream reservoirs. The highest mean daily flow recorded at the Trenton Station was 279,000 cfs, which occurred on August 20, 1955.

The headwaters for Crafts Creek lie in north-central Burlington County. The creek discharges into the Delaware River near the eastern boundary of the site. A weir was installed at the mouth of Crafts Creek by the former steel plant owners to form a 40-acre pond along the eastern boundary of the site, between NJ State Highway Route 130 and the river.

The USGS maintains a crest-stage, partial-record gaging station in Crafts Creek at Columbus, New Jersey, approximately midway between the creek's headwater and its confluence with the Delaware River. The drainage area for this station is 5.38 square miles. The annual maximum flow recorded at this gaging station in 1988 was 191 cfs. Two discharge outfall pipes from the RSC are located on the western bank of Crafts Creek, just prior to the point of discharge to the Delaware River.

The banks of the Delaware River adjoining the RSC are relatively steeply sloped. Floodway and Flood Hazard Delineation maps, prepared by the NJDEP in the mid-1980s for this area, show that the 100-year floodplain hugs the Delaware River shoreline. Only two parcels of land in the western end of the site, covering approximately 32,000 square feet in the slag pile area and 50,000 square feet in the wharf area, are designated as Flood Hazard Areas for a 100-year flood. In addition, the Federal Emergency Management Agency has delineated a 500-year floodplain for this reach of the Delaware River. The 500-year floodplain essentially overlaps, and extends beyond, the limits of the 100-year floodplain.

Slopes along the western bank of Crafts Creek immediately adjacent to the site are also quite steep. No 100-year floodplain is present for this area of the creek, although a 100-year and 500-year floodplain boundary has been designated for the area of Crafts Creek south of the railroad line.

The Delaware River, in the vicinity of the RSC, is part of the freshwater portion of the estuary located in the Delaware River Basin Commission (DRBC) Water Quality Zone 2, between the head of tide at Trenton, NJ and Northeast Philadelphia, PA. Water quality within the 8 mi^2 zone is characterized by the DRBC as good to fair, with chemical and bacteriological quality adequate to safely support continuous primary contact recreation. However, only 3 mi^2 of Zone 2 are classified as "fishable supported." The remaining 5 mi^2 are classified as "fishable not supported," including the area adjacent to the RSC, since advisories have been issued on the consumption of channel catfish due to polychlorinated biphenyls (PCBs).

Climate

The climate of the site region is largely continental, chiefly as a result of the predominance of winds from the interior of North America. Climatological data for the period 1931-1972 have been compiled from the nearby Pennsylvania Meteorological Station of the National Weather Service in Philadelphia.

The climate of the site is influenced by the Appalachian Mountains to the west and the Atlantic Ocean to the east. Average temperature is 53.5 degrees Fahrenheit (°F), with July the hottest month (75.6°F) and January the coldest (32.3°F). The record high temperature was 104°F; the record low was -5°F.

Precipitation is moderate and well-distributed throughout the year. Rainfall during the summer months is slightly greater than during the winter and averages 42.48 inches per year. Snowfall in the area averages 21.3 inches per year, although as much as 44.3 inches fell during the winter of 1966-1967. The most rain and snow recorded in a 24-hour period was 5.68 inches and 14.6 inches, respectively.

Five years of surface wind data covering 1985 through 1989 were compiled from the Philadelphia, Pennsylvania station. The mean annual wind speed at the Philadelphia Station is 10.1 miles per hour (mph). The predominant wind directions are from the northwest in the winter, and from the southwest in the summer. Calm conditions (below 2 mph) occurred during 0.79 percent of the observations.

1.4.2 Nature and Extent of Contamination

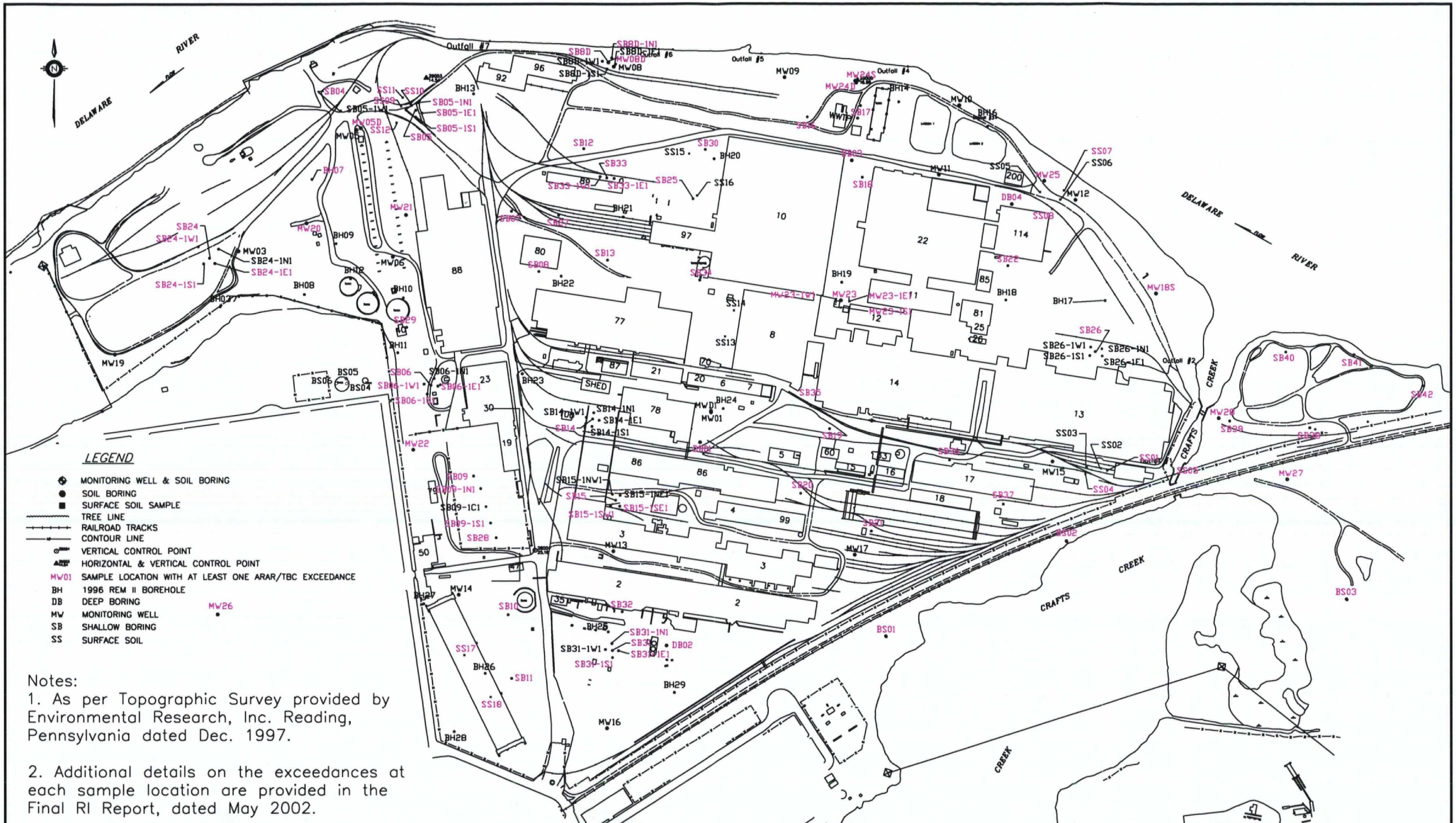
Multiple phases of field investigations were performed to characterize soil, groundwater, seeps, surface water, and sediments associated with the RSC. The primary results and conclusions regarding the field investigations are summarized below. Figures 1-5 through 1-8 provide the exceedances detected in soils, groundwater and groundwater seeps, and sediments (both near the site and regionally), respectively.

Soils

Surface Soils (0-2 feet)

- Low levels of volatile organic compounds (VOCs) were detected in surface soils throughout most of the site; however, no VOCs were detected in surface soils at levels exceeding the most stringent ARARs/To Be Considered (TBCs) (NJ-residential/non-residential direct contact or USEPA soil screening level criteria). Toluene, chloroform, and xylene were the most widespread VOCs detected at the site in surface soil. Large numbers of VOCs, consisting of aromatic and chlorinated organic compounds, were detected in the surface soil in numerous facility areas. This class of compounds is commonly found in petroleum products and various manufacturing materials (i.e., solvents) that were in widespread use during the former manufacturing process.

- PAHs were the most frequently detected semi-volatile organic compounds (SVOCs) at the site exceeding the state/federal criteria. The highest concentration of PAHs in surface soil was detected near Building 89, adjacent to a railroad spur. PAHs are typically associated with



Notes:

1. As per Topographic Survey provided by Environmental Research, Inc. Reading, Pennsylvania dated Dec. 1997.

2. Additional details on the exceedances at each sample location are provided in the Final RI Report, dated May 2002.

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Roebling Steel Company Site

Figure 1-5

Soil Sample Locations (Shallow and Subsurface) With at Least One ARAR/TBC Exceedance

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FS Figure 1-5 071202.dwg

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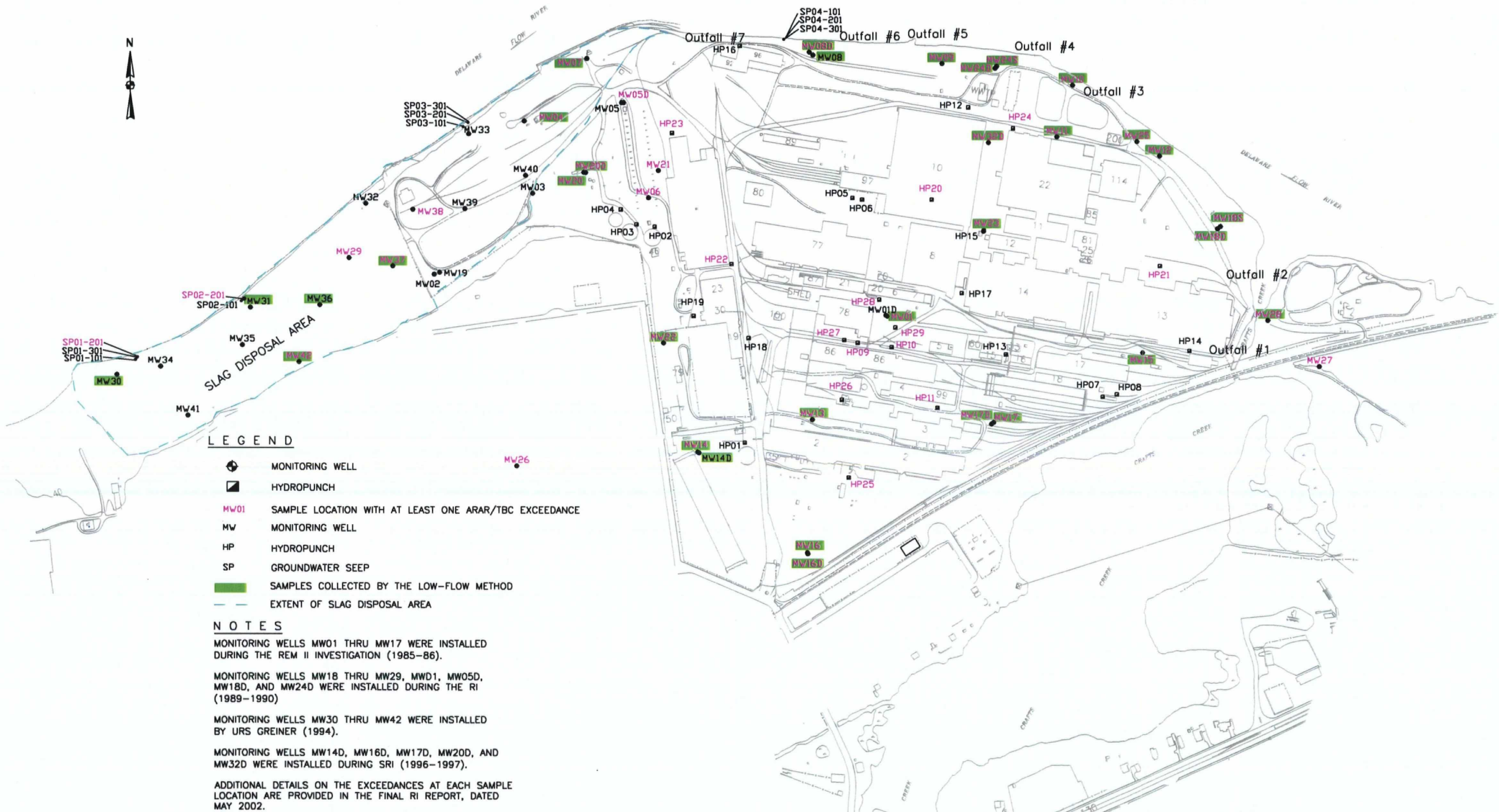

LEGEND

- MONITORING WELL
- HYDROPUNCH
- MW01 — SAMPLE LOCATION WITH AT LEAST ONE ARAR/TBC EXCEEDANCE
- MW — MONITORING WELL
- HP — HYDROPUNCH
- SP — GROUNDWATER SEEP
- SAMPLES COLLECTED BY THE LOW-FLOW METHOD
- EXTENT OF SLAG DISPOSAL AREA

NOTES

MONITORING WELLS MW01 THRU MW17 WERE INSTALLED DURING THE REM II INVESTIGATION (1985-86).

MONITORING WELLS MW18 THRU MW29, MWD1, MW05D, MW18D, AND MW24D WERE INSTALLED DURING THE RI (1989-1990)

MONITORING WELLS MW30 THRU MW42 WERE INSTALLED BY URS GREINER (1994).

MONITORING WELLS MW14D, MW16D, MW17D, MW20D, AND MW32D WERE INSTALLED DURING SRI (1996-1997).

ADDITIONAL DETAILS ON THE EXCEEDANCES AT EACH SAMPLE LOCATION ARE PROVIDED IN THE FINAL RI REPORT, DATED MAY 2002.

Map information is based on Foster Wheeler Environmental Corporation, Ludgate Engineering Corporation and Environmental Research, Inc. datum as well as information provided by URS Greiner.

0 250 500
FEET

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Roebling Steel Company Site

Figure 1-6
Monitoring Well, HydroPunch, and Groundwater Seep Sample Locations With at Least One ARAR/TBC Exceedance

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FS Figure 1-6 071502.dwg

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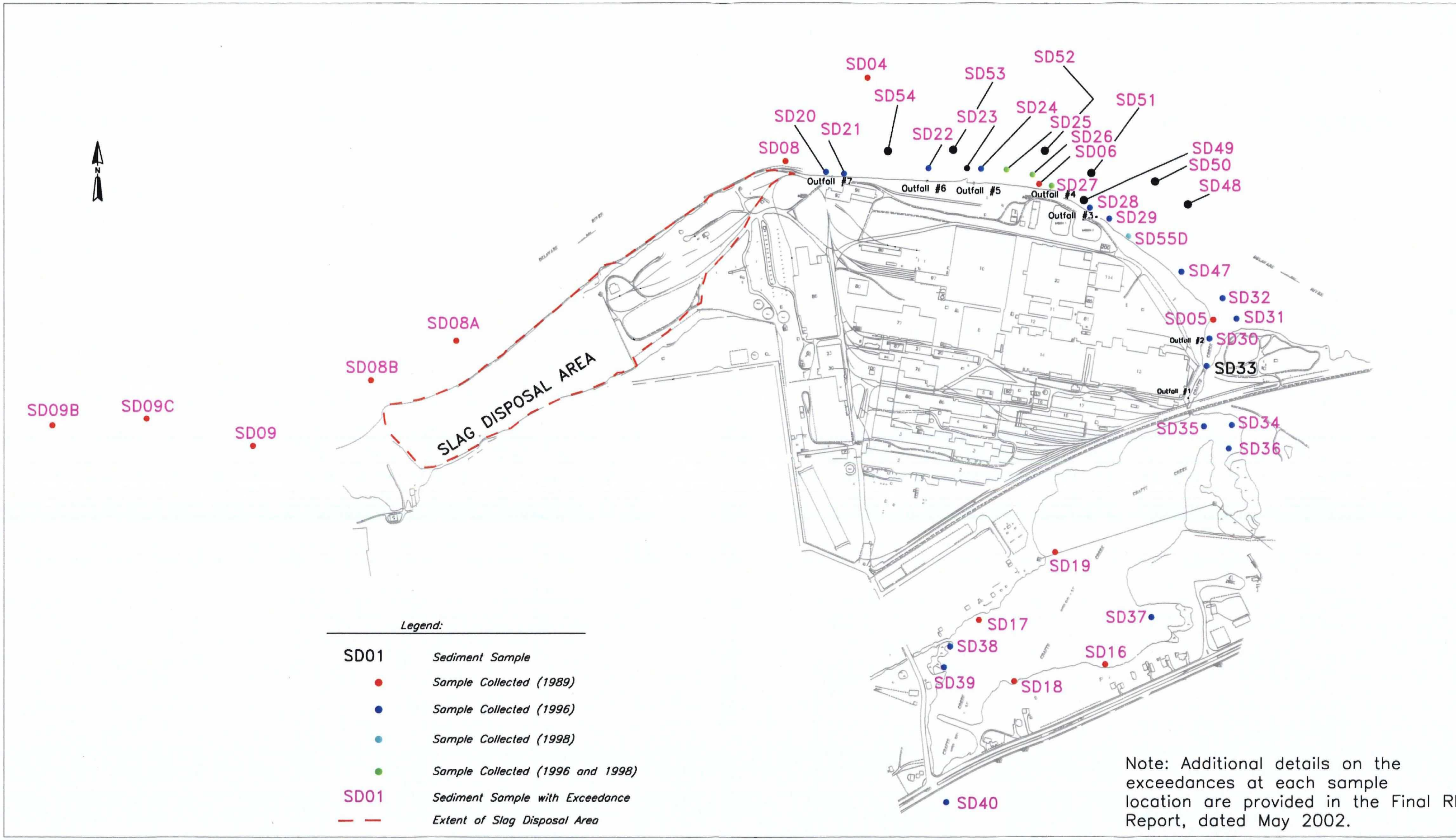

Note: Additional details on the exceedances at each sample location are provided in the Final RI Report, dated May 2002.

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Roebling Steel Company Site

Figure 1-7

Sediment Sample Locations Near Site With at Least One LEL Exceedance

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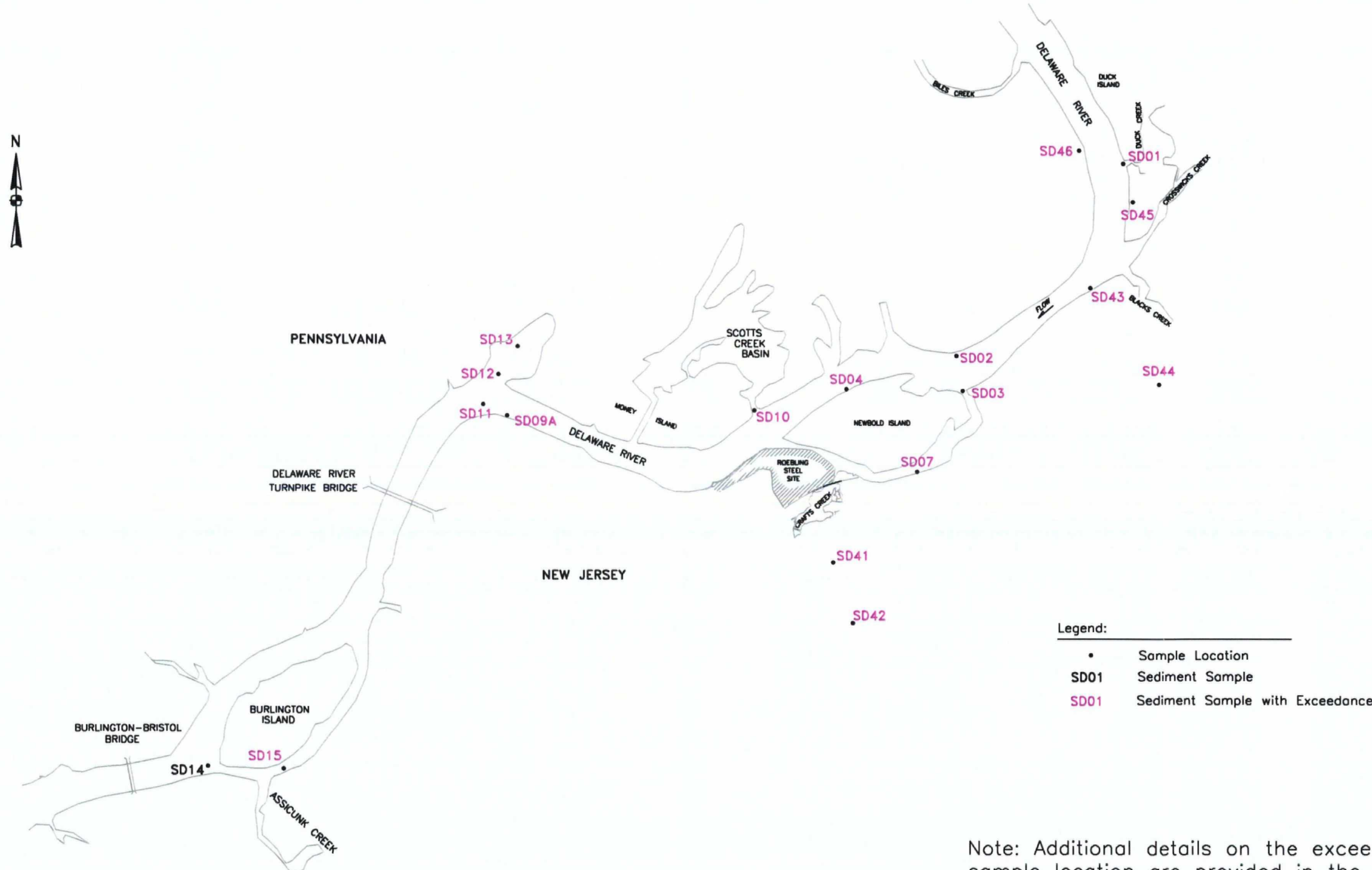
FS Figure 1-7 071202.dwg



Note: Additional details on the exceedances at each sample location are provided in the Final RI Report, dated May 2002.

0 1/2 1 mile

FS Figure 1-8 071602.dwg

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Roebling Steel Company Site

Figure 1-8

Regional Sediment Sample Locations With At Least One LEL Exceedance

FOSTER WHEELER ENVIRONMENTAL CORPORATION

construction materials or fill material such as oiled roadways and fill materials (slag/coal ash/cinders) which are abundant at the RSC.

- Twelve PCB exceedances were detected in surface soil during the RI. PCB exceedances were also detected in confirmation samples collected in the former transformer areas. This contamination is most likely associated with historic discharges of PCB-containing materials in the vicinity of the transformer operations.

- Lead, chromium, and cadmium were the most frequently detected inorganic compounds exceeding the ARARs/TBCs in surface soil. The metal exceedances were widespread across the site, indicating a source of these metals in the fill materials. Lead and other metals were also present in acid rinse/process water generated from former operations, indicating that residual contamination from former discharges at the site also contributed to this surface soil contamination.

Subsurface Soils (>2 feet)

- Two VOCs, 1,1,2,2-tetrachloroethane and vinyl chloride, were detected in one sample, and each exceeded the most stringent ARARs/TBCs. In addition, generally low levels of VOCs were identified in the facility areas of the RSC, most frequently toluene, acetone, methylene chloride, and methylethylketone (MEK). The sources of these VOCs include petroleum products and solvents associated with aboveground storage tanks (ASTs)/USTs and former degreasing areas at the RSC.

- SVOCs consisting predominantly of PAHs were present throughout the former manufacturing facility areas, exceeding the most stringent subsurface soil/impact to groundwater criteria. PAHs, as represented by benzo(a)pyrene, were distributed mostly in the shallow subsurface soils from 2 to 4 feet below ground surface (bgs) in numerous locations. The distribution of PAHs decreased significantly below this depth, indicating sorption onto soil and low mobility. The distribution in soil of SVOCs/PAHs suggests impacts from historic activities in the manufacturing areas, although PAHs are also likely to be related to sources of contamination in the fill materials (slag, coal ash, cinders, etc.), as well as in other materials present at the site (oily substances, asphalt, etc.).

- The distribution of exceedances of PCBs in shallow subsurface soils, 2 to 4 feet, was more limited than SVOCs, with only three total PCB exceedances detected. The potential source of the PCBs is the historic discharge of PCB-containing materials in the vicinity of the transformer operations.

- Metals exceedances were detected primarily in the shallow subsurface soils (2 to 4 feet bgs) throughout the former manufacturing facility area. Low levels of metals, most commonly arsenic, lead, antimony, and chromium, were widespread in the shallow subsurface soil at the site with areas of localized metal exceedances. The widespread metal contamination in the 2 to 4 foot depth appears to be the result of impacts from historic surface activities at the site, including placement of fill materials containing slag, cinders, and other metallic debris, as well as more localized discharges of metal-containing process waters.

- Metals exceedances were also detected in the deeper subsurface soil (4 to 7 feet bgs), but the frequency and distribution was much more limited than in the surface soil at the site. Areas of localized exceedances were noted for antimony, arsenic, lead, and chromium. The primary source/mechanism of the deeper soil contamination may be discharges of liquid waste materials at the site during the former operations.

Electrical Substation Soils

- Soil samples collected from the electrical substation area exhibited two concentrations which exceeded ARARs/TBCs: benzo(a)pyrene and pentachlorophenol. No other concentrations exceeded ARARs/TBCs.

Stressed Vegetation Soils

- Six soil samples collected from areas exhibiting stressed vegetation were collected. A few SVOCs were detected at concentrations exceeding ARARs/TBCs in one or more samples, most frequently benzo(a)pyrene. Three pesticides (aldrin, dieldrin, and lindane) were detected at concentrations exceeding ARARs/TBCs, but no metals were detected at concentrations exceeding ARARs/TBCs.

Test Pit Soils

- Soil samples were collected from 10 test pits during the RI. Three SVOCs (benzo(a)pyrene, bis(2-ethylhexyl)phthalate, and pentachlorophenol) and two pesticides (alpha-BHC and beta-BHC) were detected at concentrations exceeding ARARs/TBCs in one or more test pit soil samples. Twelve metals, including antimony, arsenic, beryllium, cadmium, chromium, copper, lead, nickel, selenium, silver, thallium, and zinc, were detected at concentrations exceeding ARARs/TBCs in one or more test pit soil samples, with cadmium and lead being the most frequent exceedances. Samples from six test pits exhibited TCLP leachate concentrations in excess of regulatory thresholds for lead and/or cadmium. TCLP data for OU-5 is provided in Appendix B of the RI (FWENC, 2002).

Groundwater

Upper Sand Aquifer

- VOC compounds were detected in groundwater in the landfill area, the Slag Disposal Area, and the manufacturing facility areas during the 1990 RI sampling round at levels which exceeded the most stringent groundwater criteria. These VOC exceedances included 1,2-dichloroethane, bis(2-ethylhexyl)phthalate, and 1,1,2,2-tetrachloroethane. Low levels of VOCs were also detected during the 1991 sampling rounds nearby and downgradient of the landfill area, suggesting that leakage of these chemicals from the landfill materials had occurred. Based upon the 1997 Supplemental Remedial Investigation (SRI) low-flow sampling data, only trichloroethene (TCE) was detected (3 micrograms per liter (ug/L) in

MW01) at a level exceeding the New Jersey Groundwater Quality Standard (NJ-GWQS) (1 ug/L), although low levels of other VOCs were detected during the SRI sampling.

- Five HydroPunch groundwater samples were collected and analyzed to characterize the TCE contamination, as described above. TCE was detected in only one of the samples (HP-26) at a level equal to the NJ-GWQS of 1 ug/L. The above data suggests that VOCs are not a significant concern in the Upper Sand aquifer at the site.

- Four SVOCs were detected at very low concentrations during the 1990 RI sampling, but none of the concentrations exceeded the groundwater quality criteria. Several PAHs were detected during the 1996/1997 HydroPunch sampling (HP-26) which exceeded the NJ-GWQS, including benzo(a)anthracene (17 ug/L), benzo(b)fluoranthene (18 ug/L), chrysene (23 ug/L), and bis(2-ethylhexyl)phthalate (5 ug/L).

- One pesticide (4,4'-DDD at 0.34 ug/L) and one PCB (Aroclor 1260 at 0.91 ug/L) were detected at concentrations exceeding NJ-GWQS during the 1996/1997 HydroPunch sampling.

- During the 1990 RI sampling, dissolved lead, arsenic, copper, beryllium, cadmium, selenium, and antimony exceedances were detected in the former manufacturing facility areas, and in the eastern portion of the Slag Disposal Area. Dissolved metal exceedances were not detected in the shallow aquifer in the Slag Disposal Area during the 1991 Focused Feasibility Study (FFS)-II sampling, although low levels of dissolved metals were detected above the background values detected. During the 1996 and 1997 low-flow sampling events, localized areas of arsenic and lead exceedances were detected in the former Slag Disposal Area. The 1990 dissolved metals data suggest that leaching of these metals has occurred in the Slag Disposal Area. The data also suggests that impacts to the shallow aquifer in the manufacturing facility areas of the site have diminished since the facility closed in the late 1980s.

- Low levels of VOCs were also detected in monitoring well MW-5D (downgradient of the landfill area) during the 1991 FFS-II groundwater sampling.

- During the 1994 sampling, several metals were detected in MW5D (downgradient of the landfill) at levels exceeding the NJ-GWQS.

Lower Sand Aquifer

- No organic compounds were detected in the Lower Sand Aquifer exceeding the most stringent groundwater ARARs/TBCs. One VOC, 1,1-dichloroethane, was detected during the 1997 deep well sampling at low levels in MW32D (3 ug/L), which is located in the area adjacent to the northeast corner of the Patenting Building. This suggests that vertical migration of dissolved organic contaminants from a surface source down to the Lower Sand Aquifer is a viable mechanism for contaminant transport in this part of the site. The above data suggest that VOCs are not a contaminant of concern in the Lower Sand Aquifer at the RSC.

- No SVOCs were detected in the Lower Sand Aquifer exceeding the groundwater criteria; however, low levels of several SVOCs were detected during the 1997 deep well sampling rounds at the site. No pesticides or PCBs were detected in the Lower Sand Aquifer at the site. The above data suggest that SVOCs and Pesticides/PCBs are not contaminants of concern in the Lower Sand Aquifer at the RSC.

- Based on the 1990 RI through 1998 SRI sampling results, numerous inorganic metals were detected in the Lower Sand Aquifer exceeding the most stringent groundwater criteria. During the 1990 RI sampling, dissolved antimony, arsenic, beryllium, lead, nickel, silver, selenium, and zinc were detected in the Lower Sand aquifer at levels exceeding the federal and/or state groundwater criteria. It should be noted that zinc was not evaluated in the FS or the modeling activities because zinc has a higher Kd value compared to other metals, such as lead, which would take a longer time to reach its cleanup standard. Thus, zinc was not evaluated in any of the modeling activities. During more recent (low-flow) sampling, localized areas of metals exceedances were detected in the Lower Sand Aquifer in the landfill area, the former Wastewater Treatment Plant/Building 10 area, and the intermediate sand layer near Building 3. Based upon the RI/SRI data, metals contamination in the Lower Sand Aquifer appears to be more persistent than in the unconfined shallow aquifer.

Groundwater Seeps

- Analysis of the groundwater seep sampling data indicates that a higher frequency of metals (aluminum, cadmium, chromium, vanadium, and zinc) was detected in the total fraction of the groundwater seep samples in the Slag Disposal Area (SP01-201, SP02-201, and SP03-201), relative to the dissolved fraction. This indicates probable impact of suspended particles on the groundwater seep sampling results, which would be expected to occur because of the method of sample collection (i.e., grab samples).

- Dissolved metals detected in the groundwater seep samples at the maximum low tide indicate that chromium (not detected (ND) to 11 ug/L) and copper (5J to 15 ug/L) are present in groundwater seeps originating from the Slag Disposal Area, and copper (22 ug/L) and zinc (37 ug/L) are present in the groundwater seep samples originating from the facility area between Outfalls #6 and #7 (SP04-201). Groundwater at low tide was found to discharge to the adjacent channel areas, which supports the presence of groundwater seeps in the channel at low tide. The groundwater sample collected from MW30 (located upgradient of SP01) contained 16 ug/L and 4J ug/L of dissolved chromium and copper, respectively, and the sample from MW8 (in the vicinity of SP04) contained 7 ug/L of dissolved copper and 0.43 ug/L of dissolved cadmium. The above data appear to provide evidence that low levels of dissolved metals are discharging to surface water in the Main Channel and possibly the Back Channel, since similar dissolved metals were detected in the groundwater seep samples and in the nearby monitoring wells during the groundwater and groundwater seep sampling program.

- The localized areas of arsenic and lead exceedances are located in the southeastern portion of the Slag Disposal Area, and not adjacent to the Main Channel area where the groundwater seeps occur. For example, no localized areas of metals exceedances were detected in groundwater monitoring wells MW8S, MW30, MW31, and MW34, which are located upgradient of the groundwater seep samples. Since these monitoring wells are located within the zone of tidal influence, the metals contamination in this area appears to have been diluted by mixing in the tidal zone. This would explain the low concentrations of metals contamination detected in the groundwater seep and groundwater samples in this portion of the site. The observation that tidal fluctuations cause concentrations in groundwater discharges (i.e., seeps) to be significantly reduced is supported by modeling efforts that are described in the scientific literature.

- Outside the Slag Disposal Area, total copper and total zinc were detected at groundwater seep sampling location SP04. The overall reduction in the variety of metals detected at this location relative to the Slag Disposal Area may reflect the difference in source areas; for example, slag materials are not as widespread in the fill materials throughout the manufacturing facility areas of the site. However, no groundwater seep samples were collected downgradient of the landfill area in the vicinity of MW07, or in the vicinity of the Wastewater Treatment Plant (MW24), where the presence of groundwater contamination was detected.

- A comparison of the concentrations of metals in the three groundwater seep sampling rounds, and a comparison of the concentrations and individual metals detected in the paired monitoring wells and groundwater seep samples, indicates an hydraulic connection between the groundwater and groundwater seep samples during dead low tide. However, shallow groundwater in the tidal zone has been mixed with influxes of surface water, which apparently has resulted in reduced concentrations of metals in the groundwater seep samples.

Surface Water

Main Channel

- Based upon a comparison of the results of the 1989 and 1996 Main Channel surface water sampling data and the 1998 groundwater seep/surface water transect data, there is some evidence to suggest that the RSC is contributing metals to the Main Channel. The surface water impacts appear to be related primarily to colloidal and/or suspended sediments/particulate matter in the samples (SP01 through SP03 and transects TR01 through TR03). Interpretation of the data indicates that the surface water contamination appears to decrease in concentration outward from the site, in a thin band parallel to the riverbank. This decrease in metals concentrations in surface water outward from the site may be related to an increase in proportional mixing and dilution of site-related discharge waters with surface water outward into the channel. The 1998 surface water data appears to indicate limited impact to surface water in the Main Channel from site discharges.

Back Channel

- Numerous detections of aluminum, copper, and manganese from Back Channel surface water samples exceeded human health and/or aquatic surface water quality criteria, and the concentrations were similar to those in the samples collected from the Main Channel. However, occasional detections of iron, lead, and silver in the Back Channel samples were found to exceed the most stringent surface water quality criteria by two-to-three times the average background concentrations found in the Main Channel samples.

- Back Channel stations revealed higher than background concentrations of iron, lead, and silver. The silver detections occurred near the intersection of Crafts Creek and the Back Channel. Silver was detected more frequently and at higher concentrations at Crafts Creek sampling stations. The distribution of metals concentrations in Back Channel surface water transect sample SP04-201 (near the confluence of the Main Channel) was similar to that of the Main Channel. In this sample, total copper and total/dissolved zinc exceeded the average background levels in the Main Channel at 15 feet into the channel at dead low tide. Impacts from iron, lead, and silver in the Back Channel area near Crafts Creek may be related to contamination associated with former discharges from Outfalls #1 and #2. Impacts from copper and zinc in the western portion of the Back Channel appear to be related to groundwater discharges.

Crafts Creek

- Eight analytes (aluminum, arsenic, copper, iron, lead, manganese, silver, and zinc) were detected at multiple sampling stations within Crafts Creek, which includes locations in the upstream portion of the ponded Crafts Creek tidal basin. Of these, only iron and lead are higher within the confines of Crafts Creek versus Main Channel/Back Channel locations. The highest aluminum, arsenic, and silver detections occurred in the background samples (SW42 and SW44), suggesting an upstream/off-site source of this contamination. Fifty percent of the lead detections in Crafts Creek exceeded the most stringent human health criteria (5 ug/L). Lead was contained in discharge waters associated with Wire Mill No. 2, which discharged via Outfall #2 into Crafts Creek. This suggests that the RSC is a potential source of this contamination. In summary, impacts from iron and lead in the Crafts Creek channel and ponded area appear to be the result of former site-related discharges and/or current discharges from the RSC and surrounding properties.

Sediment

Main Channel

- During the 1989 sediment sampling in the Main Channel of the Delaware River, SVOCs, consisting of one PAH, and one pesticide were detected downstream of the RSC exceeding the Low Effects Level (LEL) benchmarks. These compounds were not detected or were detected below the concentrations in the upstream background samples. During 1996, numerous PAHs and pesticide exceedances were detected in upstream sediment sample locations at higher concentrations than in the downstream samples.

- Numerous metals (arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc) were detected during the 1989 sediment sampling conducted in the Main Channel at levels exceeding the LEL benchmarks in both upstream and downstream sample locations. The metal concentrations were generally higher in the downstream sampling locations. Numerous metals were also detected in upstream background sample locations during the 1996 sampling at levels which exceeded the LEL benchmarks.

- Although it is difficult to draw absolute conclusions due to the tidal nature of the Delaware River in the vicinity of the site (i.e. sediments in the channel are transported upstream and downstream with the tidal currents), the RSC is considered a contributor to the observed sediment contamination.

Back Channel

- During the 1996 sampling in the Back Channel area, numerous SVOCs consisting of PAHs were detected adjacent to the site at levels exceeding the LEL benchmarks. The PAHs were detected in the sediments deposited near Outfalls #3, 4, 5, and 6, and near the mouth of Crafts Creek, with the highest concentrations and variety of PAHs identified near Outfall #5 (SD24). The second highest level of PAHs was detected in the sediment sample located upstream of the site. Since higher levels of PAHs were detected at the site relative to the upstream sediments in the Main Channel, the site is a potential source of the PAH contamination in the Main Channel. The most likely source of the PAH contamination was particulate matter in surface water runoff that discharged through the storm sewer system to the channel.

- Pesticide exceedances were also detected in 1996 in the Back Channel area adjacent to the site at various locations along the channel. However, the greatest variety and concentrations of pesticides were detected in upstream sediment sample location SD46 in the Main Channel. Although the RSC may be contributing some pesticides to the sediments in the Back Channel area, it does not appear that the RSC can account for the levels and variety of pesticides that were detected in the Main Channel.

- Numerous metals (arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc) were detected in the Back Channel sediments adjacent to the site at levels exceeding the LEL benchmarks. The highest concentrations of metals were detected during 1989 and 1996 in the area surrounding the former Wastewater Treatment Plant/Outfall #4. Although the metal concentrations detected throughout the Main Channel also exceeded the LEL benchmarks, most metal concentrations in the Wastewater Treatment Plant area substantially exceeded the levels detected in the Main Channel samples. Historic discharges of effluent from the Wastewater Treatment Plant are the most likely source of this metals contamination. These discharges may also have contributed significantly to the current level of sediment contamination in the Main Channel.

Crafts Creek Channel and Wetlands

- Numerous SVOCs consisting of PAHs were detected in the sediment samples collected in the Crafts Creek channel (north and south of the railroad right-of-way (ROW)) exceeding the LEL benchmarks. No PAH exceedances were detected in the sediment samples collected as background samples. Particulate matter and debris in surface water runoff from the RSC storm sewer system, which discharged via Outfalls #1 and #2 to the Crafts Creek channel, is a probable contributor to this contamination. The highest concentrations of PAHs were detected in two sediment samples collected in the upstream portion of the Crafts Creek wetland and ponded area. Surface water runoff in the form of sheet flow and channel flow, or local storm sewer outfalls that discharge from various properties and ROWs surrounding the wetland/ponded area, including the RSC, are the most likely sources of this SVOC contamination. In addition, as stated in the RI (Foster Wheeler Environmental, 2002), oily wastes were released through stormwater/sewer lines, thereby making the RSC a contributing source of PAH contaminants in Crafts Creek, the Main Channel, and associated wetlands. PAH contamination may have also been due to particulate matter in surface runoff that discharge through the storm sewer.

- Pesticide compounds frequently exceeded the LEL benchmarks in the sediment samples collected in the Crafts Creek channel/wetland area and in the upstream samples collected as background samples. However, the frequency of detection and concentrations of pesticides were somewhat higher in the Crafts Creek sediment samples than in the background samples. The widespread occurrence of these compounds in the Crafts Creek study area suggests impacts from surface water runoff on properties that have used pesticides, such as commercial and residential properties, public/private transportation ROWs, and other properties, including the RSC.

- Widespread metals exceedances were detected in the Crafts Creek channel and throughout the wetland/ponded area. The highest concentrations of cadmium, chromium, copper, and manganese were detected in the Craft Creek channel area, north and south of the railroad trestle over Crafts Creek, near Outfalls #1 and #2. This suggests impacts from historic discharges of process waters from the nearby former RSC manufacturing facility areas (Buildings 13, 14, 17, and 19), as well as impacts from metals adsorbed to suspended particles and debris in the RSC stormwater runoff. The highest concentrations of lead, iron, mercury, zinc, and nickel were associated with sediment samples collected in the upstream portion of the Crafts Creek wetland. Potential sources of this contamination include stormwater runoff from the surrounding areas, including the RSC, as described above, and dissolved phase and colloidal size metal particles in groundwater discharges, which may accumulate in sediment by sorption onto solid particles and organic materials, by precipitation, or by other chemical processes that take place at the groundwater/surface water interface.

1.4.3 <u>Contaminant Fate and Transport</u>

VOCs are present in samples from potential sources of contamination and environmental media. There is evidence that low-level VOCs may be present in groundwater; however, no concentrated accumulation (e.g., localized area of groundwater exceedances) is evident. Therefore, volatilization of VOCs from soils and groundwater appears to be the major fate mechanism for VOCs in site soils, and off-site migration of VOCs in groundwater is believed to be of secondary importance. Since volatilization appears to be the primary fate of VOCs, VOCs are not likely to persist in site media.

SVOCs are present in samples from potential sources of contamination, as well as in soil samples from around the site, and sediment samples from upriver, downriver, and near the site. However, the infrequent occurrence of the SVOCs in groundwater and surface water samples, along with the relatively low concentrations reported in aqueous media suggest that: 1) adsorption is the primary fate mechanism for the SVOCs in site soils and sediment; 2) the SVOCs are persistent in soils and sediment at the site; and 3) migration into groundwater or surface water is minimal.

Pesticides and PCBs were detected in soil samples from around the site and in sediment samples. There is little evidence, however, for transport of pesticides or PCBs from site matrices into groundwater or into nearby surface water bodies (no positive detections). Analytical results of samples from various site environmental media support the general conclusion derived from the physicochemical behavior of pesticides and PCBs; that is, that pesticides and PCBs are likely to persist in their current locations on the site. However, off-site transport of pesticides and PCBs may occur to a limited extent by physical removal of contaminated particles, via surface run-off, or wind-blown transport.

Elevated concentrations of metals are virtually ubiquitous in environmental media, which is consistent with the primary use of the site as a metal processing and steel manufacturing facility. Results of analysis of site groundwater suggest that the metals of concern may be migrating from soils into groundwater; however, the overall importance of subsequent groundwater transport of metals appears to be limited. It is likely that the most important mechanism for the mobility of metals is colloidal or particulate transport mobilized by a combination of river water as bank storage, combined with groundwater and discharged to surface water through groundwater seeps. Particulates are mobilized in groundwater seep discharges. The water table fluctuates greatly due to tidal effects. Based on the cross-sections presented in the RI (Foster Wheeler Environmental, 2002), the depth to groundwater ranges from 2 feet below mean sea level (msl) to 21 feet above msl. Thus, there is an extensive amount of contaminated soil and slag material present below the water table. Dilution, deposition of solid phases, and precipitation appear to be limiting the impacts of site discharge to surface water. The impacted nature of the Delaware River, from both the RSC and other sources along the River, makes it difficult to discern whether this mechanism has widespread adverse impact.

1.4.4 Human Health Risks

The approach taken in preparing the RSC human health baseline risk assessment was to use USEPA-approved exposure models coupled with conservative assumptions about exposure conditions to generate reasonable maximum exposure (RME) and central tendency (CT) estimates of the baseline (no further remedial action assumed) health risks associated with chemical contamination of site environmental media.

Contaminants of potential concern (COPCs) were identified on the basis of exceedance of toxicological screening criteria developed by the State of New Jersey and the USEPA (USEPA, 1998c) and/or background concentrations. The site media concentration used in the screening process was the maximum detected concentration.

RME scenarios were evaluated using the 95 percent upper confidence limit (UCL) of the mean contaminant concentrations, or the maximum detected concentration if the UCL value exceeded the maximum concentration, combined with conservative but realistic exposure parameters. CT exposure scenarios were evaluated using the 95 percent UCL contaminant concentrations, combined with 50 percent UCL exposure parameters from USEPA guidance.

Current site land use provides the potential for exposures to a child trespasser and to off-site residents via the migration of windblown site soil particulates. Future land use is projected to include site redevelopment which could result in resident, commercial site worker, and construction worker receptors. Exposure pathways chosen for quantitative or qualitative analysis at the RSC consisted of the following:

- Ingestion, inhalation, and dermal contact with contaminants in current and future site surface soil (on-site trespassers, adult/child residents, site workers, construction workers);
- Inhalation of contaminants in particulates derived from on-site surface soil (off-site adult/child residents);
- Current and future ingestion and dermal contact with contaminants in site subsurface soil (on-site adult/child residents, site workers);
- Current and future ingestion, inhalation, and dermal contact with contaminants in site subsurface soil (on-site construction workers);
- Ingestion, inhalation of, and dermal contact with contaminants in site groundwater (adult/child residents, site workers (ingestion only));
- Ingestion, inhalation, and dermal contact with contaminants in surface water from the Delaware River (adult/child residents, site workers (ingestion only));
- Ingestion and dermal contact with contaminants in sediment in the Delaware River (adult/child residents);
- Ingestion and dermal contact with contaminants in the sediment and surface water in Crafts Creek (adult/child residents); and
- Ingestion of fish from Crafts Creek (adult/child residents).

COCs were identified based on the risk assessment as those COPCs that resulted in site-specific risks greater than 1 x 10^{-6} or noncarcinogenic risks greater than 1.0. RME exposures for all receptors, present and future, would exceed the lower end of the cancer risk range of 10^{-4} to 10^{-6}. Specifically, current trespassers and off-site residents, future on-site adult/child residents, commercial site workers, and construction workers may be exposed to COPCs in the surface soil, subsurface soil, groundwater, surface water, and sediment. RME estimated risks exceed $1x10^{-4}$ for future potential adult residents and child residents potentially exposed to arsenic in groundwater. The RME hazard index is greater than the benchmark of 1.0 for the sum of all Hazard Quotients (HQs) for each receptor.

CT exposures for future adult/child residents and commercial site workers would exceed the lower end of the cancer risk range of 10^{-4} to 10^{-6}. Specifically, future on-site adult/child residents and commercial workers may be exposed to COCs in the surface soil, subsurface soil, groundwater, surface water, and sediment. CT estimated risks exceed $1x10^{-4}$ for future potential child residents potentially exposed to arsenic in groundwater. The CT hazard index is also greater than the benchmark of 1.0 for the sum of all HQs for the adult/child residents.

The COCs are identified in each site medium with the exception of the Delaware River surface water. The COCs identified in the surface soil are benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, hexachlorobenzene, Aroclor-1254, Aroclor-1260, dieldrin, antimony, arsenic, lead, and manganese. The COCs identified in the subsurface soil are benzo(a)pyrene, dibenzo(a,h)anthracene, arsenic, and lead. The COCs identified in the groundwater are trichloroethene and arsenic. The COCs identified in the Delaware River sediment are benzo(a)pyrene and dibenzo(a,h)anthracene. The COCs identified in Crafts Creek sediments are benzo(a)pyrene, benzo(a)anthracene, and benzo(b)fluoranthene, while 4, 4'-DDE, 4, 4'-DDD, mercury, and copper were identified as COCs in fish tissue from Crafts Creek. The COC for surface water in Crafts Creek is lead.

1.4.5 Ecological Risks

Assessment endpoints for the RSC Ecological Risk Assessment (ERA) were identified for the Delaware River and Crafts Creek, as follows:

- Sustained aquatic community structure, including community composition and relative abundance;
- Sustained use of habitat by the endangered shortnose sturgeon (*Acipenser brevirostrum*) and other fish species in the Delaware River adjacent to the RSC;
- Protection of avian fauna exposed to contamination in impacted media; and
- Maintenance and propagation of resident fish populations.

To address the assessment endpoints, the following measurement endpoints were employed:

- Community-level analysis employing quantitative and qualitative effects based assessment including:
    - Comparison and screening of abiotic media samples (surface water and sediments) against applicable Ambient Water Quality Criteria (AWQC) as well as LEL and severe effects level (SEL) guidance values;
    - Community analysis of benthic macroinvertebrates in the Back Channel area and Crafts Creek, inclusive of whole sediment toxicity testing with *Chironomus tentans* and *Hyalella azteca;*
- Evaluation of shortnose sturgeon life history in the vicinity of the site, identification of significant habitats, and exposure/effects-based comparisons;
- Effects based exposure assessment for semi-aquatic avian species (i.e., great blue heron, *Ardea herodias*) potentially exposed to site-related contaminants through ingestion of contaminated biotic and abiotic media; and

- Comparison of resident fish body burdens to No Observed Adverse Effects Level (NOAELs) and Lowest Observed Adverse Effects Level (LOAELs) from the scientific literature.

Screening of the Delaware River surface water revealed limited exceedances of acute and chronic AWQCs in the Main Channel and Back Channel. Crafts Creek surface water displayed a greater exceedance of chronic AWQCs associated with copper, lead, and iron. Iron and lead were also found to exceed the chronic AWQCs at the reference stations. From the 1998 sampling effort, copper most frequently exceeded the acute and chronic AWQCs at most stations including the reference stations upgradient from the site. Aluminum, lead, and zinc also sporadically exceeded acute and chronic AWQCs. Historically elevated metal levels in Zone 2 have been attributed to the industrial nature and major uses of the surface water within the zone below Trenton, NJ (DRBC, 1987).

Analytical results for sediments revealed metal and PAH contamination in the Back Channel and Crafts Creek when compared to the Main Channel. This is based on exceedances of the screening criteria and guidance values.

RSC-related metals which exceeded LEL and SEL sediment screening values in the Back Channel and Crafts Creek sediments included arsenic, iron, copper, chromium, lead, manganese, nickel, and zinc. PAH concentrations in both the Back Channel and Crafts Creek sediments, when normalized to station-specific organic carbon, were found to only exceed the LEL in most locations.

Impacts from the contaminants of potential ecological concern (COPECs) observed in the benthic community included a communal shift to taxa known to tolerate sediments contaminated with metal wastes. These effects were further verified with whole sediment toxicity testing, which resulted in observed reductions in survival and growth of two representative invertebrates (i.e., epibenthic amphibod *Hyalella azteca* and infaunal midge *Chironomus tentans*) in sediments from the most severely contaminated areas of the Back Channel and Crafts Creek. The observed shifts in benthic community structure and toxicity were significantly correlated to the site-related COPECs.

The primary site-related COPEC for avian endpoint receptors was lead (Pb), and the primary exposure pathway for this element was identified as the incidental ingestion of sediments. This pathway contributed 80 percent of the total lead to a representative wading bird with an 11 percent dietary composition of sediments. If a 100 percent lead source attribution to sediments was considered, a sediment threshold concentration of 233 mg/kg Pb would result in a reproductive NOAEL hazard quotient equal to one (1.0). Additionally, a sediment threshold concentration of 479 mg/kg Pb would result in a reproductive LOAEL hazard quotient equal to one (1.0). Crafts Creek sediments present in the wetland areas represented the primary exposure source medium.

Warmwater fish species sampled from Crafts Creek were found to have an elevated body burden of copper, lead, and zinc relative to reference regional tissue concentrations. Lead is not a required micronutrient and thus tends to accumulate in tissues, but is not biomagnified within the food chain. Comparison to estimated NOAEL or LOAEL values identified lead as being potentially problematic in fish tissues of Crafts Creek.

Review of shortnose sturgeon life history revealed that this species tends to remain in deeper channel environments, at depths well in excess of those observed in the Back Channel. The Back Channel does represent a potential foraging area for this species, and contamination of the sediments represents a degradation of potential foraging habitat for the sturgeon. However, the Back Channel environment does not present preferred habitat and population monitoring has not confirmed their presence (Brundage, H., personal communication, 1998). Therefore, the feeding ecology of the sturgeon could result in exposure to site-related COPECs via ingestion of biota and sediments in the Back Channel if sturgeon forage there.

The following areas were identified and delineated as having significant impacts or posing risks to the receptors evaluated as part of the RSC ERA. Identification of the Areas of Concern were determined based upon the presence of identified RSC-related COPECs which posed risks to the benthic community, and avian and fish receptors. The measurement endpoints used to delineate these areas are described prior to each description.

Back Channel

The primary endpoint employed for the inclusion of the following areas as potential areas in need of remedial activity was based upon observed toxicity to benthic test organisms. The secondary coincidental endpoint was the exceedance of sediment-based lead threshold levels for avian receptors. A secondary endpoint included the exceedance of NOAEL or LOAEL levels in tissues of resident fish species for site-related metals.

- Area No. 1 (Outfalls # 3 and #4) - is delineated by SD24 on the west, a point between SD47 and SD55 on the east and extending outward into the center of the Back Channel to SD48, SD50, and SD52. SD51 displayed a reduction in survival of *Hyalella azteca*, a type of amphipod, and it is therefore assumed that this portion of the perimeter extends further out from this station. This area includes, in its perimeter, a large intertidal area vegetated by emergent macrophytes.

- Area No 2 (Outfall #6) - consists of SD22 and SD54 where statistically significant reductions in survival of *Hyalella azteca* were observed. Since no significant reductions in survival in either test organism was observed at SD53, near the center of the channel and offshore from the above stations, the areal extent appears confined to near-shore subtidal sediments.

Crafts Creek

The primary endpoint employed for the inclusion of the following areas was based upon observed toxicity to benthic test organisms, and/or the exceedance of sediment-based lead threshold levels for avian receptors. A secondary endpoint included the exceedance of NOAEL or LOAEL levels in tissues of resident fish species for site-related metals.

- Area No. 1 (SD35, SD34, SD36) - is delineated by the identified three stations and is inclusive of all subtidal sediments, due to toxicity to benthic organisms and risks to avian receptors from elevated lead concentrations exceeded corresponding NOAEL and LOAEL threshold exposure concentrations.

- Area No. 2 (SD18, SD16, SD37) - is delineated by the identified three stations and is inclusive of all subtidal sediments to a maximum water depth of up to 3 feet, as risks to avian receptors from lead concentrations exceeded the NOAEL and LOAEL at these three locations.

- Area No. 3 (SD38, SD39) - is delineated by the identified stations in the associated wetland area and is inclusive of subtidal sediments since toxicity to benthic organisms was observed.

Results of the ERA identified risks to benthic communities; freshwater, resident fish; and semi-aquatic avian receptors from exposure to site-related metals in sediments. Risks to benthic communities came as of result of direct contact with heavy metals in submerged sediments adjacent to the site. Risks to freshwater, resident fish were inferred based upon bioaccumulation of site-related metals (i.e., lead) and exceedance of body burdens associated with known effects-based thresholds. Risks to semi-aquatic avian receptors were associated with the incidental ingestion of site-related contaminants in near-shore sediments. Remediation of the identified areas of sediment contamination would assist in the overall reduction of risks to the ecological receptors through an elimination of a source and/or reduction in the overall exposure point concentration to the above ecological receptors.

1.5 GROUNDWATER MODELING

As presented in Appendix D, a three dimensional groundwater model was developed for the RSC. The modeling was performed in a 3 step process that included:

1) Development of a calibrated steady-state groundwater flow model for the site.

2) Development of a transient contaminant transport model for the site.

3) Simulation of various groundwater remediation scenarios using the transport model.

The Department of Defense Groundwater Modeling System (GMS) computer code was used for the modeling utilizing USGS MODFLOW 96 3D code for groundwater flow, USGS MODPATH 96 3D code for particle tracking, and MT3DMS 3D code for multi-species transport.

The flow model was successfully calibrated to measured on-site conditions on May 3, 1990. The transport model was developed using the calibrated flow model to represent the hydrogeologic system at the site. Various areas at the site in the Upper and Lower Sand aquifers were identified as having lead, arsenic, and beryllium contamination. The highest concentration measured at each area was used to simulate a groundwater contaminant plume at that location in the transport model. The model successfully simulated the development of these plumes over a 50-year time frame and then was used to simulate the plumes an additional 50 years into the future. The modeling showed that with constant mass loading (no source removal) the concentrations increased in the plumes over the 50 years but the geometry did not expand.

Tidal fluctuations were not part of the modeling effort. The heads used in the river package were the average head distributions in the Delaware River between low tide and high tide. The pumping wells are within the tidally affected area of the Upper and Lower Sands; however, the average tidal fluctuation of the head in the Upper Sand is 0.75 feet, while the drawdown in the area of the pumping wells is several feet. The average tidal fluctuation of the head in the Lower Sand is 1.04 feet, while the drawdown in the area of the pumping wells is several feet. The drawdown of the pumping wells is much greater than the tidal fluctuation. Therefore, the tidal fluctuations would not have a significant impact on the model predictions. In addition, the modeling takes place over an extended period of time, so using the average head in the Delaware River is reasonable.

The base transport model was used to simulate various remediation scenarios including:

1) Source removal above and below the water table and natural attenuation of the dissolved phase metals.

2) Source removal above and below the water table and active pumping and treating of the dissolved phase metals contamination.

3) No source removal and active pumping and treating of the dissolved phase metals contamination.

4) Hydraulic containment using a cutoff wall in conjunction with extraction wells.

The conclusions gleaned from the modeling of the remediation scenarios included:

- Under current conditions with no source removal, the metals contaminant plumes will increase in concentration but will not expand.

- The metals contaminant plumes will naturally remediate in approximately 90,000 years if the sources are removed.

- The metals contaminant plumes will be remediated in approximately 35,000 years if a pump and treat system is installed, pumping at 93 gallons per minute, and the sources are removed.

- The metals contaminant plumes will not be remediated if a pump and treat system is installed and the sources are not removed.

- Groundwater containment can be achieved in the area of impacted river sediments with an approximately 2,000 foot long cutoff wall and seven extraction wells pumping at a total of 70 gallons per minute.

- Implementation of a groundwater remediation effort is considered technically impracticable.

1.6 OU-3 SLAG AREA SOILS

This section summarizes the Pre- and Post- ROD Investigations and discusses the rationale of proposed changes to the selected remedy for the slag area (OU-3).

1.6.1 1991 Focused Feasibility Study

USEPA conducted a field investigation consisting of two stages in 1988 and 1989 to determine the type and extent of contamination in the slag area. Surface and subsurface soil samples were collected at specific depth intervals up to 45 feet below grade and analyzed for full organic and inorganic parameters. In addition, selected samples were analyzed for EP Toxicity and TCLP to determine the leaching behavior of the slag material. The volume of slag material that was thought to leach contaminants into the groundwater, thus needing treatment, was estimated to be approximately 30,000 cy at that time. The analytical results are presented in their entirety in the FFS completed in June 1991.

In the 1990 ROD, USEPA selected a remedy for a 34-acre slag area, which includes treating hot spots of contamination, defined as slag material that fails a TCLP test, and then covering the entire 34-acre slag area with a soil cap and vegetation, a stormwater management system, shoreline protection and institutional controls. The estimated volume for treatment of 30,000 cy in the selected remedy was based on a limited number of samples analyzed for EP Toxicity and TCLP tests; therefore, it was anticipated that additional surface and subsurface sampling to further delineate hot spot areas would be necessary during the remedial design.

The cap would consist of two feet of top soil and vegetation extending to the side slopes. The grading contours of the soil cap would support a stormwater management system that collected and conveyed runoff to the Delaware River while providing improvement in surface water quality. A small portion of the slag area that is located in the 100-year floodplain would be graded to above the floodplain elevations. A riprap stone revetment would be placed from the edge of the soil cap down into the surface water to mitigate potential erosion of the shoreline. The slag material in those areas designated as hot spots would be excavated and treated on-site using a mobile treatment unit. Leachability would be determined by testing the slag material using the TCLP analysis. Stabilization of the slag material would physically or chemically bind contaminants of concern within an insoluble matrix, significantly reducing their potential to leach. Dewatering of slag material found below the water table would be necessary during its excavation. The extracted water would be collected, treated, and disposed in accordance with federal and state requirements. Since the existing remedy would result in treated material remaining on-site, a long-term groundwater and surface water monitoring program, periodic site inspections, and a review every five years would be required to determine the effectiveness of this remedy. Institutional controls would be implemented to restrict future excavations through the soil cap, especially in those areas that were stabilized. Future land uses would be limited by zoning or deed restrictions, which would be specified in the real estate transactions of the property.

1.6.2 1999 Pre-Design Investigation

In 1991, the USACE was given the responsibility to design and implement the remedy selected for the slag area. A Pre-Design Investigation to delineate hot spot areas and to further characterize the slag area was conducted, and the results are presented in the PIR issued by the design contractor, URS Consultants, Inc., in May 1999.

Hot Spot Delineation

Stages 1 and 2 of the hot spot delineation were performed in the fall of 1993 and 1994, respectively. The results of TCLP testing for metals during the Stage 1 investigation confirmed the presence of the hot spot previously identified in the 1991 FFS, and identified three new hot spot areas. Exceedances were detected for lead and cadmium only. Lead concentrations exceeding the TCLP limit of 5 mg/kg ranged from 5.9 mg/kg to 1,080 mg/kg. Lead exceedances were found at the surface, as well as at significant depths. Cadmium concentrations exceeding the TCLP limit of 1 mg/kg ranged from 14.1 mg/kg to 23.5 mg/kg. The results of TCLP testing during Stage 2 further refined the hot spot limits delineated in Stage 1. Water table elevations were depicted on cross-sections of the hot spot areas to illustrate TCLP exceedances with respect to the water table. Approximately a third of the TCLP exceedances reported in the four hot spot areas were below the water table.

The volume of slag material estimated during the Pre-Design Investigation is approximately 710,000 cy, with 210,000 cy exceeding the TCLP criteria. The spatial area associated with the hot spot zones is approximately eight acres. Additional volume estimates for the remaining portions of the site were also calculated for future consideration, since any remedy implemented for the slag area should be consistent with cleanup plans for the main plant area; a large part of the main plant area was built over slag fill. These calculations show the volume of slag material over the remaining portions of the Site to be approximately 1,300,000 cy, with approximately 390,000 cy expected to exceed TCLP criteria.

Groundwater Investigation

As part of the pre-design work, a phased groundwater investigation in the slag area was conducted in the fall of 1993 and 1994, and the spring and summer of 1996. Considering the increase in volume of hot spot material, it was decided to measure the actual contaminant concentrations in the groundwater to determine whether hot spots were a source of contamination, rather than using the TCLP test to predict the leaching behavior of the slag material.

Thirteen shallow monitoring wells were installed and sampled for metals, along with the five existing wells. The locations of the new wells were situated to monitor groundwater quality upgradient, downgradient, as well as within the hot spot areas. Since substantial differences in the concentrations of metals from both filtered and unfiltered analyses were identified during previous sampling events for the FFS and the concurrent RI, precautions were taken to obtain a more representative sample. This was accomplished by using a low flow pump rather than a bailer during well purging and sampling. The low flow method of purging and sampling provides a less disturbed sample. Therefore, the unfiltered samples should mirror more closely the natural conditions of the aquifer. These results are presented in both the PIR and RI reports, and were included as part of the groundwater model effort.

Additional Investigations

As part of the pre-design work in 1996, surface water samples were collected to determine potential impact of the groundwater discharge on the Delaware River. A total of five samples were taken immediately upriver, adjacent, and immediately downriver of the slag area, and analyzed for dissolved and total metals. Concurrent with the surface water sample collection in the slag area, six sediment samples were collected from three-near shore locations adjacent to the slag area (northern end, center, and southern end) and analyzed for metals concentrations, sediment toxicity and benthic macroinvertebrate community structure and diversity. The analytical results of the surface water and sediment samples are presented in the PIR.

Pre-Design Investigation Conclusions

Based on the analytical results from the hot spot delineation, groundwater, surface water and sediment investigations, the metal contaminants present in the slag material and groundwater did not show a significant impact on the biota in the sediments and the quality of the surface water. The ground water tests suggest that metals were present in the ground water, principally as suspended particulates, and to a much lesser degree, as the result of leaching. Therefore, it was determined that the application of the TCLP test was inappropriate, and the impacts of the slag material would be investigated further as part of the OU-5 RI.

SECTION 2.0

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2.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

2.1 INTRODUCTION

The following is the three-step process for the identification and screening of potential technologies to remediate the contamination associated with OU-5 and re-evaluate the selected remedy for OU-3 at the RSC.

- RAOs are developed based on contaminant characterization, risk assessment and compliance with risk-based action levels and/or ARARs (Section 2.2);
- General response actions are identified that will satisfy the RAOs (Section 2.3); and
- Potential technologies and process options for each of the general response actions are identified, screened and evaluated (Section 2.4).

The technologies and process options that pass this screening are combined into remedial alternatives in Section 3.0.

2.2 REMEDIAL ACTION OBJECTIVES

In this section, site-specific RAOs are presented. RAOs are based on public health and environmental concerns, and on ARARs. ARARs for the site are presented in Section 2.2.1 and RAOs are detailed in Section 2.2.2.

2.2.1 Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered Materials (TBCs)

Pursuant to CERCLA and the National Contingency Plan (NCP), remedial actions shall comply with and upon completion attain ARARs. Applicable requirements are defined by the NCP (40 CFR 300.5) as those cleanup standards, standards of control and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental and facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site. Relevant and appropriate requirements are defined (40 CFR 300.5) as those cleanup standards, standards of control and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental and facility siting laws that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance found at a CERCLA site, address problems or situations sufficiently similar to those encountered at CERCLA sites that their use is well suited to a particular site. A requirement that is relevant and appropriate must be complied with to the same degree as if it were applicable. In addition to applicable or relevant and appropriate requirements, the lead agency may, as appropriate, identify other advisories, criteria or guidance TBC. It is important to note that only those state standards that are identified by the state in a timely manner and that are more stringent than the federal requirements may be considered ARARs (40 CFR 300.400(g)(4)).

ARARs may be categorized as chemical-, location- or action-specific:

- Chemical-specific ARARs set health or risk-based concentration limits or ranges in various environmental media for specific hazardous substances, pollutants or contaminants. Examples include maximum contaminant levels (MCLs) for groundwater, federal AWQC and RCRA groundwater protection standards.

- Location-specific ARARs set restrictions on activities within specific locations, such as wetlands and floodplains, and depend on the characteristics of a site and its immediate environs. Examples include federal and state wetland protection laws and sites on the National Register of Historic Places.

- Action-specific ARARs set controls or restrictions on particular kinds of remedial activities that may be selected to accomplish a remedy. These ARARs may specify particular performance levels, actions or technologies to be used to manage hazardous substances, pollutants or contaminants. Examples include RCRA regulations for closure of hazardous waste storage or disposal units and RCRA Land Disposal Restrictions.

Associated with action-specific ARARs are the material management strategies for handling hazardous versus non-hazardous waste. Any materials that fail TCLP criteria need to be managed as hazardous waste, including transportation, disposal, and meeting LDRs. These materials cannot be disposed on site and must be transported to a permitted hazardous waste facility. Materials that do not fail the TCLP criteria would be managed as non-hazardous waste. Additional material management strategies must be applied for the disposal of material from the landfill area (included as part of OU-5). Since this landfill received RCRA listed hazardous waste (e.g., baghouse dust), the excavated material from this area would need to be transported to a permitted facility that accepts RCRA listed hazardous wastes. Extra precautions may be taken to ensure that the RCRA listed waste does not come into contact with the other excavated soils in the vicinity of the landfill, otherwise they too would need to be managed as a RCRA listed hazardous waste. TCLP tests may also be performed on the landfill material to fully characterize the waste.

Remedial actions conducted entirely "on-site" must comply with ARARs and the substantive aspects of permitting, but not the administrative aspects of permitting (specifically exempted under CERCLA Section 121(e)) or administrative reviews. Administrative procedures are not considered ARARs and, therefore, need not be pursued during the planning or implementation of remedial actions.

Activities occurring outside of the defined CERCLA site boundaries are considered off-site. Off-site activities are not controlled by ARARs, but rather must comply with all federal, state and local requirements. Occupational Safety and Health Administration (OSHA) requirements are also not considered ARARs pursuant to the US Environmental Protection Agency adopted final rule on the NCP. However, the NCP identified certain OSHA requirements that must be complied with during all CERCLA response actions (i.e., 29 CFR 1910 and 1926).

Potential ARARs/TBCs for OU-5 are presented in Table 2-1.

TABLE 2-1 (Sheet 1 of 9)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND REQUIREMENTS TO BE CONSIDERED (TBCs)

ARAR/TBC TYPE	REQUIREMENT	CITATION	DESCRIPTION	COMMENTS
CHEMICAL				
	FEDERAL			
	Safe Drinking Water Act Regulations	40 CFR 141	Drinking water standards which apply to specific contaminants and which have been determined to have an adverse impact on human health.	Drinking water standards, expressed as Maximum Contaminant Levels (MCLs), are potential ARARs for groundwater and/or surface water cleanup and replacement standards.
	Ambient Water Quality Criteria	Guidance Criteria	Guidelines established for the protection of human health and/or aquatic organisms.	Potential ARAR for contaminants that lack a promulgated MCL, otherwise criteria are considered TBCs.
	RCRA Groundwater Protection Standards	40 CFR 264.94	Maximum constituent concentrations for groundwater protection at hazardous waste management facilities.	Potential ARAR for groundwater cleanup and replacement standards.
	Aquatic Sediment Quality Guidelines (Ontario)	Guidance Criteria	Guidelines for screening contaminants in freshwater sediments.	Potential TBC for contaminants in the Delaware River and Crafts Creek.
	Draft Soil Screening Guidance	Guidance Criteria	Establishes soil screening levels (SSLs) for specific contaminants and exposure pathways.	Potential TBC for contaminants in OU-5 soils.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND REQUIREMENTS TO BE CONSIDERED (TBCs)

ARAR/TBC TYPE	REQUIREMENT	CITATION	DESCRIPTION	COMMENTS
CHEMICAL				
	(Continued)			
	Sediment Quality Screening	Guidelines for Deriving Site-specific Sediment Quality Criteria for the Protection of Benthic Organisms, 9/93 (EPA 822-R-93-017)	Guidance document prepared by USEPA for developing sediment quality criteria for organic elements that are reflective of local conditions.	Potential TBC for developing sediment quality standards.
	STATE			
	Surface Water Quality Standards	NJAC 7:9B	Water quality standards for various classes of surface waters.	Potential ARAR for surface water cleanup standards and/or effluent limitations on discharges to surface waters.
	Groundwater Quality Standards	NJAC 7:9-6	Groundwater quality standards for various classes of groundwater.	Potential ARAR for groundwater cleanup and replacement where more stringent than MCLs.
	Safe Drinking Water Act Standards	NJAC 7:10-5.2	Contains the state's discretionary changes to the federal drinking water standards.	Drinking water standards, expressed as MCLs, are potential ARARs for groundwater and/or surface water cleanup and replacement standards.
	Industrial Site Recovery Act	NJSA 13:1K	Requires that soil remediation standards for human carcinogens for all NJ cleanups be calculated at a risk factor of one additional cancer risk in one million.	Potential TBC for setting soil remediation criteria.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND REQUIREMENTS TO BE CONSIDERED (TBCs)

ARAR/TBC TYPE	REQUIREMENT	CITATION	DESCRIPTION	COMMENTS
CHEMICAL				
	(Continued)			
	Soil Cleanup Criteria	New Jersey Soil Cleanup Criteria (5/99)	Sets restricted (residential) and un-restricted (non-residential) soil cleanup standards and impact to groundwater criteria.	Potential TBC for contaminants in on-site soils.
	Sediment Quality Evaluations	NJDEP Guidance for Sediment Quality Evaluations (11/98)	Guidance for the evaluation of sediment quality to be used in the ecological risk assessment process.	Potential TBC for evaluating sediment quality standards.
LOCATION				
	FEDERAL			
	Protection of Wetlands	Executive Order 11990	Requires consideration of impacts to wetlands in order to minimize their destruction, loss or degradation and to preserve/enhance wetland values.	Potential ARAR for activities which would impact wetlands.
	Protection of Floodplains	Executive Order 11988	Requires consideration of impacts to floodplain areas in order to reduce flood loss risks, minimize flood impacts on human health, safety and welfare and preserve/restore floodplain values.	Potential ARAR for activities occurring within the 100-year, and 500-year floodplain.
	Endangered Species Act	16 USC 1531	Establishes requirements for the protection of federally listed threatened and endangered species and their habitat.	Potential ARAR for activities which could affect threatened or endangered species or their habitat.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND REQUIREMENTS TO BE CONSIDERED (TBCs)

ARAR/TBC TYPE	REQUIREMENT	CITATION	DESCRIPTION	COMMENTS
LOCATION				
	(Continued)			
	National Historic Preservation Act	16 USC 470	Establishes requirements for the identification and preservation of historic and cultural resources.	Potential ARAR for disturbance activities which could impact historic and cultural resources.
	Archeological Resources Protection Act	16 USC 470aa	Provides for the protection of archeological resources located on public lands.	Potential ARAR for management of any archeological resources discovered during remediation activities.
	Fish and Wildlife Coordination Act	16 USC 661	Requires consideration of impacts to wildlife resources resulting from the modification of waterways.	Potential ARAR for on-site activities which would result in the diversion or other modification of rivers/ streams.
	Clean Water Act, Section 404(b)(1) Guidelines	40 CFR 230.10	Establishes criteria for evaluating impacts to waters of the US (including wetlands) and sets forth factors for considering mitigation measures.	Potential ARAR for placement of fill or dredge material into on-site wetlands.
	Rivers and Harbors Act, Section 10 regulations	33 CFR 320-330	Requirements for evaluating the placement of structures and/or excavation activities within navigable waters.	Potential ARAR for remedial actions involving the management of contaminated sediments.

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TABLE 2-1 (Sheet 5 of 9)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND REQUIREMENTS TO BE CONSIDERED (TBCs)

ARAR/TBC TYPE	REQUIREMENT	CITATION	DESCRIPTION	COMMENTS
LOCATION				
	(Continued)			
	Resource Conservation and Recovery Act Location Standards	40 CFR 264.18	Regulates the design, construction, operation and maintenance of hazardous waste management facilities including various citing criteria.	Potential ARAR for on-site treatment, storage or disposal of hazardous waste.
	Wetlands Protection at Superfund sites	OSWER 9280.0-03	Guidance document to be used to evaluate inpacts to wetlands at Superfund sites.	Potential TBC for impacts to freshwater and tidal wetlands.
	STATE			
	Flood Hazard Area Regulations	NJAC 7:13	Regulates the placement of fill, grading, excavation and other disturbances within the defined flood hazard area/floodplain of rivers/streams.	Potential ARAR for site activities occurring within the flood hazard area or floodplain of on-site rivers/streams.
	Wetlands Act of 1970 Regulations	NJAC 7:7-2.2	Regulates the disturbance or alteration of mapped tidal wetlands and their respective buffers.	Potential ARAR for site activities disturbing tidal wetlands and buffer areas.
	Waterfront Development Regulations	NJAC 7:7-2.3	Regulates development activities (including dredging/excavation) below the mean high water line of coastal waterways and extending up to 500 feet landward.	Potential ARAR for site activities resulting in the placement of structures, soil excavation and/or dredging/fill placement within the Waterfront Development zone.

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TABLE 2-1 (Sheet 6 of 9)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND REQUIREMENTS TO BE CONSIDERED (TBCs)

ARAR/TBC TYPE	REQUIREMENT	CITATION	DESCRIPTION	COMMENTS
LOCATION				
	(Continued)			
	Coastal Resource Development Policies	NJAC 7:7E	Specifies the state's coastal resources policies for all regulated activities within the coastal zone; a Federal Consistency Review of potential remedial alternatives will be assessed by NJDEP.	Potential ARAR for site activities occurring within the Waterfront Development zone and/or within mapped tidal wetlands.
	Delaware River Basin Compact	NJSA 58:18	Requirements for activities impacting water resources within the Delaware River Basin.	Potential ARAR for on-site activities involving the withdrawal and discharge of groundwater.
	Riparian Lands Management	NJSA 12:3	Provides a mechanism for the issuance of grants/leases for activities within mapped currently and previously flowed riparian lands ("tidelands").	Potential ARAR for site activities which occur within mapped riparian lands associated with tidal waterways.
	Freshwater Wetlands Protection Act Rules	NJAC 7:7A	Regulates the disturbance or alteration of freshwater wetlands and their respective buffers and provides for mitigation requirements.	Potential ARAR for site activities disturbing freshwater wetlands and buffer areas.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND REQUIREMENTS TO BE CONSIDERED (TBCs)

ARAR/TBC TYPE	REQUIREMENT	CITATION	DESCRIPTION	COMMENTS
ACTION				
	FEDERAL			
	Hazardous Waste Generation	40 CFR 262	Specifies requirements for hazardous waste packaging, labeling, manifesting and storage.	Potential ARAR for on-site management of hazardous waste.
	Treatment, Storage and Disposal of Hazardous Waste	40 CFR 264/265	Specifies requirements for the operation of hazardous waste treatment, storage and disposal facilities.	Potential ARAR for on-site hazardous waste treatment, storage and disposal activities.
	Land Disposal Restrictions	40 CFR 268	Sets out prohibitions and establishes standards for the land disposal of hazardous wastes.	Potential ARAR for on-site hazardous waste disposal activities.
	National Ambient Air Quality Standards-Particulates	40 CFR 50	Establishes maximum concentrations for particulates and fugitive dust emissions.	Potential ARAR for on-site activities which would generate particulate emissions.
	National Emission Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR 61	Establishes limitations for the emission of defined hazardous air pollutants.	Potential ARAR for remedial activities which would generate hazardous air pollutants.
	Clean Water Act Effluent Guidelines and Standards	40 CFR 401	Provides requirements for point source discharges of pollutants.	Potential ARAR for discharges of wastewaters to surface water bodies.
	Clean Water Act Stormwater Program	40 CFR 122	Regulates the discharge of stormwater from industrial activities.	Potential ARAR for point source discharges of stormwater to surface waters.

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TABLE 2-1 (Sheet 8 of 9)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND REQUIREMENTS TO BE CONSIDERED (TBCs)

ARAR/TBC TYPE	REQUIREMENT	CITATION	DESCRIPTION	COMMENTS
ACTION				
	(Continued)			
	USDOT Hazardous Materials Transportation Regulations	49 CFR 171-180	Establishes classification, packaging and labeling requirements for shipments of hazardous materials.	Potential ARAR for the preparation of hazardous materials generated on-site for off-site shipment.
	In-situ Capping of Sediments	USEPA Assessment and Remediation of Contaminated Sediments Program, 12/98 (EPA-905-B96-004)	Requirements and options available for the inplace disposal of contaminated sediments.	Potential TBC Although developed for sediment management from Great Lakes Waters, elements within the guidance can be referenced in evaluating restoration alternatives.
	USEPA Test Methods for Evaluation of Solid Waste	SW-846	Establishes analytical requirements for testing and evaluating solid/hazardous wastes.	Potential TBC for testing waste samples.
	STATE			
	Sanitary Landfill Requirements	NJAC 7:26-2A	Requirements for the engineering, construction, operation and maintenance of sanitary landfills.	Potential ARAR for the on-site disposal of non-hazardous wastes.
	Hazardous Waste Management Regulations	NJAC 7:26G	Provides requirements for the generation, accumulation, on-site management and transportation of hazardous waste.	Potential ARAR for on-site management and disposal of hazardous waste.

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TABLE 2-1 (Sheet 9 of 9)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND REQUIREMENTS TO BE CONSIDERED (TBCs)

ARAR/TBC TYPE	REQUIREMENT	CITATION	DESCRIPTION	COMMENTS
ACTION				
	(Continued)			
	Air Quality Regulations	NJAC 7:27	Provides requirements applicable to air pollution sources.	Potential ARAR for the generation and emission of air pollutants.
	Technical Requirements for Site Remediation	NJAC 7:26E	Specifies standards for investigation, remediation, and closure at contaminated sites.	Potential ARAR for sampling and analysis during remediation activities.
	Water Pollution Control Regulations	NJAC 7:14A	Rules regarding discharges of wastewater to surface waters, groundwater and publicly owned treatment works.	Potential ARAR for discharges of on-site generated wastewater and stormwater.
	Treatment Works Approvals	NJAC 7:14A-22	Design and construction standards for wastewater treatment systems.	Potential ARAR for on-site treatment of wastewater.
	Soil Erosion and Sediment Control	NJSA 4:24	Requires the implementation of soil erosion and sediment control measures for activities disturbing over 5,000 square feet of surface area of land.	Potential ARAR for site activities involving excavation, grading or other soil disturbance activities exceeding 5,000 square feet.
	Well construction and maintenance; sealing of abandoned wells	NJAC 7:9D-1 et. seq.	Provides requirements for installing and abandoning wells, permitting of wells, and licensing of well drillers.	Potential ARAR for site activities involving wells used for sampling, monitoring, extraction, and/or recovery.

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2.2.2 Medium-Specific Objectives

Remedial action objectives have been developed considering all identified site concerns and contaminant pathways. Remedial action objectives for the contaminated media at the RSC are presented below. Table 2-2 presents the most stringent ARAR/TBC target cleanup levels for the contaminated media.

Soils (including the Slag Disposal Area)

- Reduce human health risks associated with direct contact to contaminated site-wide soils based on current and anticipated future uses. Current reuse scenarios for the site do not include residential uses;
- Reduce risk to ecological receptors due to exposure to contaminated soils to acceptable levels;
- Prevent metals-contaminated soils and slag from leaching contaminants into site groundwater and adjacent surface water bodies, where groundwater impacts have been identified; and
- Comply with ARARs and TBCs consistent with current and anticipated future use, or request waivers.

With respect to soils, remedial action objectives are based on the results of the baseline risk assessment and comparison to ARARs/TBCs. Risk assessment results indicate risks in excess of the target carcinogenic risk range of 10^{-4} to 10^{-6} and the target hazard index of 1.0 associated with current and future use exposures to site-wide surface soils. Primary contributors to these risks include: benzo(a)pyrene, dibenz(a,h)anthracene, arsenic, and antimony. Also, qualitative risk characterization indicated potential human health threats due to lead in site-wide surface soils under both current and future use scenarios. ARARs/TBCs were used to evaluate areas of the site exhibiting concentrations of these contaminants requiring remedial action. These ARARs/TBCs included the USEPA Soil Screening Levels (SSLs) and the NJDEP Soil Cleanup Criteria. Results for benzo(a)pyrene and lead are representative of this comparison. Benzo(a)pyrene was detected in 60 percent of the surface soil samples collected and 83 percent of the detected concentrations exceeded ARARs/TBCs (50 percent of the total samples). As discussed in the RI Report and summarized in Section 1.0, the distribution of samples exhibiting detected concentrations and ARAR/TBC exceedances is throughout the entire site area. Confirmation sampling performed during the SRI determined that contamination is not limited to hotspots. For lead, 99 percent of the surface soil samples exhibited detected concentrations and 62 percent of the samples exhibited concentrations exceeding ARARs/TBCs. As with benzo(a)pyrene, distribution of the detected concentrations and the exceedances was throughout the site and not limited to hot spots. These results indicate that all site-wide surface soils at the site require some form of remedial action. Most of the subsurface soil exceedances were detected within the top four feet bgs; however, hot spot exceedances were detected at depths of eight to ten feet bgs. Thus, the volume of subsurface soil to be addressed is 861,000 cy, as presented in Appendix A.

TABLE 2-2 (Sheet 1 of 2)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
ARARs AND TARGET CLEANUP LEVELS

Constituent[6]	Groundwater[1]	Sediment[1]	Surface Water[1]	Soil[1]
	Most Stringent[2]	Most Stringent[3]	Most Stringent[4]	Most Stringent[5]
Volatile Organics				
Trichloroethene	1	NA[8]	NA	60
1,1,2,2-tetrachloroethane	1	NA	NA	3
Vinyl Chloride	NL[7]	NL	NL	3
1,1-dichloroethane	50	NL	NL	NL
1,2-dichloroethane	2	NL	NL	NL
Semi-Volatile Organics				
Benzo(g,h,i)perylene	-	170	NA	
Indeno[1,2,3-cd]pyrene	-	200	NA	900
Benzo[b]fluoranthene	0.2	-	NA	900
Benzo[k]fluoranthene	0.2	240	NA	900
Chrysene	0.2	340	NA	9000
Benzo(a)pyrene	0.02	370	NA	90
Benzo[a]anthracene	0.1	261	NA	900
Phenanthrene	-	240	NA	NC[10]
Acenaphthene	400	-	NA	100000
Dibenz[a,h]anthracene	0.3	-	NA	90
2,4-Dinitrotoluene	NL	NL	NL	0.8
Bis(2-ethylhexyl)phthalate	4	NL	NL	46000
Hexachlorobenzene	NL	NL	NL	100
Pentachlorophenol	NL	NL	NL	30
Pesticides				
4,4'-DDD	NA	0.0022	NA	3000
4,4'-DDE	NA	0.0022	NA	2000
Dieldren	NA	0.002	NA	4
Endrin aldehyde	NA	0.003	NA	1000
Endosulfan Sulfate	NA	-	NA	18000
ALDRIN	NL	NL	NL	40
Aroclor 1242	NL	NL	NL	490
Aroclor 1248	NL	NL	NL	490
Aroclor 1254	NL	NL	NL	490
Aroclor 1260	NL	NL	NL	490
"Total" Inorganics				
Antimony	5	-	6	5
Arsenic	8	6	0.017	20[11]
Barium	1,000	-	2,000	700
Beryllium	1	-	-	0.1
Cadmium	4	0.6	0.54	1
Chromium	100	26	10	38
Copper	1,000	16	4.45	600
Lead	5[9]	31	0.97	400
Manganese	50	460	50	NC
Mercury	-	0.15	0.012	1
Nickel	100	16	7	130

TABLE 2-2 (Sheet 2 of 2)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
ARARs AND TARGET CLEANUP LEVELS

Constituent[6]	Groundwater[1] Most Stringent[2]	Sediment[1] Most Stringent[3]	Surface Water[1] Most Stringent[4]	Soil[1] Most Stringent[5]
Silver	2	-	1.9	34
Thallium	NL	NL	NL	0.7
Vanadium	NL	NL	NL	370
Zinc	5,000	-	81	1500
"Dissolved" Inorganics				
Antimony	5	NA	6	5
Arsenic	8	NA	0.017	20 [11]
Barium	1,000	NA	2,000	700
Beryllium	1	NA	-	0.1
Cadmium	4	NA	0.54	1
Chromium	100	NA	10	38
Copper	1,000	NA	4.45	600
Lead	5(10) [9]	NA	0.97	400
Manganese	50	NA	50	NC
Mercury	-	NA	0.012	1
Nickel	100	NA	7	130
Silver	2	NA	1.9	34
Thallium	NL	NL	NL	0.7
Vanadium	NL	NL	NL	370
Zinc	5,000	NA	81	1500

Notes:

1. All values are represented as ug/l (parts per billion) except soils concentrations, which are mg/kg (parts per million).
2. Most stringent groundwater concentrations represent the most stringent conditions between NJ Class IIA Groundwater Quality Criteria and Federal MCLs.
3. Most stringent sediment concentrations represent the most stringent conditions between Canadian Low Effects Level (LEL), Canadian Severe Effects Level (SEL), U.S. Effects Range - Low (ER-L) and U.S. Effects Range - Medium (ER-M).
4. Most stringent surface water concentrations represent the most stringent conditions between Minimum Surface Water Aquatic Dissolved Standards (SWAQD), Minimum Surface Water Aquatic Total Standards (SWAQT) and Mimimum Surface Water Human Health Total Standards (SWHHT).
5. Most stringent soil concentrations represent the most stringent conditions between EPA Soil Screening Levels (Migration to Groundwater, Ingestion and Inhalation), and NJDEP Soil Cleanup Criteria (Impact to Groundwater, Non-Residential Direct Contact and Residential Direct Contact).
6. The constituents listed in this table are based on the Contaminants of Potential Concern (COPCs), as discussed in Section 6.2.2 of the RI.
7. NL = Not listed as a COPC for this medium.
8. NA = Not analyzed.
9. Although the GWQC for lead is 5 ug/L, the Practical Quantitation Limit (PQL) is 10 ug/L. NJDEP policy is to use the higher of the GWQC or POL as the cleanup value.
10. NC = No criterion derived for this contaminant.
11. The selected value for most stringent criterion for arsenic is the NJDEP Soil Cleanup Criterion for Direct Contact. The EPA SSL for ingestion value of 0.4 mg/kg is more stringent; however, use of this criterion would not provide for meaningful discussion since all detected concentrations exceed this value.

Sediments

- Reduce risks to ecological receptors due to exposure to contaminated sediments to acceptable levels; and

- Comply with ARARs and TBCs consistent with current and anticipated future use, or request waivers.

With respect to sediments, the following areas were identified and delineated as having significant impacts or posing risks to the receptors evaluated as part of the ERA. These areas are shown in Figure 2-1.

Back Channel of the Delaware River

Area No. 1 (Outfall No. 3 and No. 4) - is delineated by SD24 on the west, a point between SD47 and SD55 on the east and extending outward into the center of the back channel to SD48, SD50 and SD52. SD51 displayed a reduction in survival of *H. azteca*, and it is therefore assumed that this portion of the perimeter extends further out from this station. This area includes in its perimeter, a large intertidal area vegetated by emergent macrophytes.

Area No 2 (Outfall No. 6) - consists of SD22 and SD54 where statistically significant reductions in survival of *H. azteca* were observed. Since no significant reductions in survival in either test organism was observed at SD53, near the center of the channel and offshore from the above stations, the areal extent appears confined to near-shore subtidal sediments.

Crafts Creek

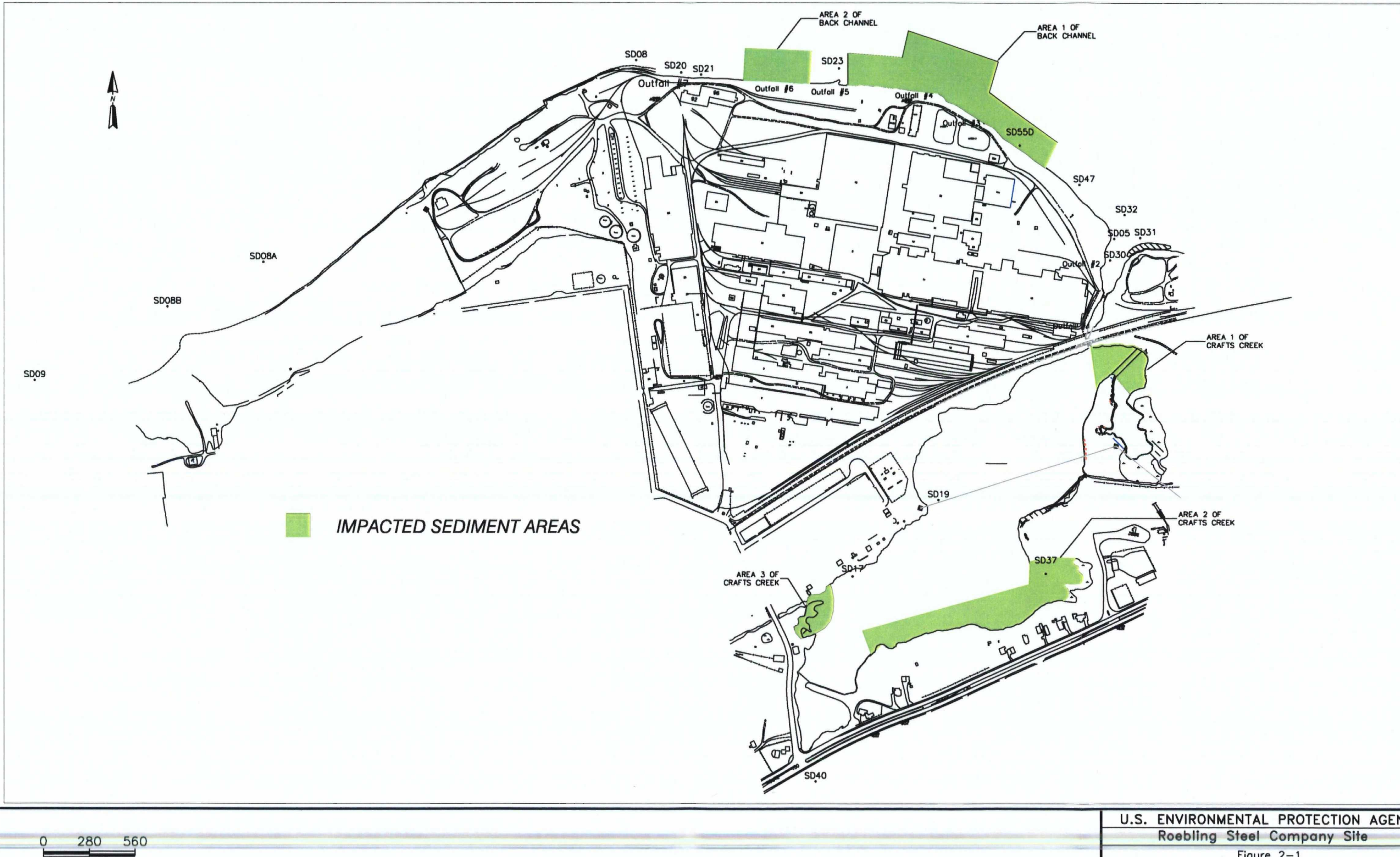
Area No. 1 (SD35, SD34, SD36) - is delineated by the identified three stations and is inclusive of all subtidal sediments, since toxicity to benthic organisms and risks to avian receptors from elevated lead concentrations exceeded corresponding NOAEL and LOAEL threshold exposure concentrations.

Area No. 2 (SD18, SD16, SD37) - is delineated by the identified three stations and is inclusive of all subtidal sediments to a maximum water depth of up to 3 feet as risks to avian receptors from elevated lead concentrations exceeded corresponding NOAEL and LOAEL threshold exposure concentrations at these three locations.

Area No. 3 (SD38, SD39) - is delineated by the identified stations in the wetland area associated with this area and is inclusive of subtidal sediments due to toxicity to benthic organisms.

Groundwater

- Reduce human health risks associated with exposure to contaminated groundwater;
- Minimize any further adverse impacts to groundwater;
- Mitigate the inhalation of vapors from, ingestion of, and dermal contact with groundwater as tap water (future receptors);



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U.S. ENVIRONMENTAL PROTECTION AGENCY
Roebling Steel Company Site
Figure 2-1
Sediment Areas of Concern

FOSTER WHEELER ENVIRONMENTAL CORPORATION

- Minimize migration of contaminated groundwater off-site; and
- Comply with ARARs and TBCs consistent with current and anticipated future use, or request waivers.

The ARARs considered in the groundwater evaluation included NJ-GWQS and MCLs. The COPCs were based on exceedances of the ARARs. If the groundwater were to be developed as a potable water source for the potential future on-site receptors, then residents and site workers would be exposed to groundwater COPCs by ingestion. Future potential residents would also be exposed by dermal contact and vapor inhalation during bathing.

The compounds detected in groundwater which exceeded the screening toxicity values for residential tap water are trichloroethene, arsenic, beryllium, lead, manganese, vanadium, and zinc. The human health baseline risk assessment notes that the COCs in the groundwater are trichloroethene and arsenic.

From the ERA, the COPECs for groundwater at the site are antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, and PAHs, such as chrysene, phenanthrene, diethylphthalate, 2-methylnaphthalene, and pyrene.

2.3 GENERAL RESPONSE ACTIONS

As discussed in Section 2.2.2, the presence of PAHs and inorganic contamination was detected in site-wide surface soils at levels exceeding ARARs/TBCs and target risk ranges. Subsurface soils had fewer detections and lower concentrations; however, the same contaminants were detected in these soils at levels exceeding ARARs/TBCs. Sediments associated with the site were found to be contaminated with PAHs and inorganics. In addition, the site groundwater was contaminated with inorganics and low-level organics.

To address the RAOs developed for the site, the following general response actions have been identified:

- No Action
- Limited Action
- Containment
- Removal/Treatment
- Disposal

The No Action alternative involves no treatment but would implement periodic reviews of site conditions. Limited Action categories involve measures that restrict use of or access to contaminated media by physical and/or administrative measures, and includes long-term monitoring.

Containment actions include technologies that involve little or no treatment, but provide protection of human health and the environment by reducing mobility of contaminants and risks of exposure. Containment actions consist of covering contaminated areas for soils/sediments and vertical barriers for groundwater.

Removal/Treatment actions include technologies that act to reduce the volume, toxicity and/or mobility of contaminants. These technologies include excavation, dredging, extraction, and treatment (physical, chemical, thermal, biological, or *in situ* for soils/sediments and physical, chemical, or biological treatment for groundwater). Disposal technologies include both on-site and off-site disposal/discharge options.

2.4 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

The screening of remedial technologies is performed in two steps; the identification and screening of technology types and process options, and evaluation and selection of representative process options.

2.4.1 Identification of Technologies and Screening Criteria

The remedial technology types associated with each of the general response actions typically considered for the cleanup of contaminated soil, sediments, and groundwater were developed from the "Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (USEPA, 1988a), "Technology Screening Guide for Treatment of CERCLA Soils and Sludges" (USEPA, 1988b), the "Guidance on Remedial Actions for Groundwater at Superfund Sites" (USEPA, 1988c), experience on other hazardous waste projects, and knowledge of innovative technologies.

Remedial technology types associated with each response action are identified in Table 2-3. Most of these remedial technology types contain several different process options that could apply to the contaminated soil and/or sediments and groundwater. These potentially applicable technology types and process options are screened based on technical implementability and effectiveness considering site-specific conditions, contaminant types and concentrations. Site-specific and contaminant-specific conditions to be addressed in the screening processes, identified from the remedial investigations, include the following:

- The RSC is located at Second Avenue and Hornberger Avenue in the Roebling section of Florence Township, Burlington County, in the State of New Jersey;
- The site covers over 200 acres and is bounded on the north and east by the Delaware River and Crafts Creek, respectively. The Village of Roebling is located to the west and south of the site property;
- Previous operations at the site included manufacturing of steel products and intermittent use for various industrial operations;
- The site was active for various purposes from 1906 until 1985;
- Sediments of concern along and within both the Back Channel of the Delaware River and Crafts Creek, fall under the classification of wetland areas; and
- The site lies in the Delaware River drainage basin, but is generally above the 100-year floodplain.

TABLE 2-3 (Sheet 1 of 4)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS

ENVIRONMENTAL MEDIA	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES	PROCESS OPTIONS
Soil (including slag) and Sediment	No Action: No Action	No Action: Site reviews	Five-year review of site conditions.
	Limited Action	Limited Action: Monitoring	Monitor and analyze environmental media to assess contaminant migration.
		Access Restrictions	Access restriction (fence, site security)
		Institutional Controls/Use Restrictions	NJDEP Declaration of Environmental Restriction (DER).
		Erosion Control/Stormwater Management	Dust suppression, site re-grading, and seeding or vegetation
	Containment: Containment	Containment Technologies: Capping	Soil cover, clay cap, asphalt cap, concrete cap, synthetic cap, multiple layer cap.
		Stormwater/Erosion Control	Riprap/trenches/culverts.
	Removal/Treatment: Removal/Treatment	Removal Technologies: Excavation	Soil Excavation
		Dredging (Sediments)	Sediment Dredging

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TABLE 2-3 (Sheet 2 of 4)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS

ENVIRONMENTAL MEDIA	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES	PROCESS OPTIONS
Soil (including slag) and Sediment (Cont'd)	Removal / Treatment (Cont'd):	Treatment Technologies:	
		Physical Treatment	Screening, stabilization/solidification, soil washing/acid leaching, dewatering.
		Thermal Treatment	Incineration, low/high temperature/thermal desorption, vitrification.
		Chemical Treatment	Solvent extraction.
		Biological Treatment	Biodegradation.
		In-Situ Treatment	Soil flushing, solidification/stabilization, biodegradation, phytoremediation.
	Disposal:	Disposal Technologies:	
	Disposal	Disposal	Off-site landfill disposal, on-site backfill, on-site disposal.

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TABLE 2-3 (Sheet 3 of 4)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS

ENVIRONMENTAL MEDIA	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES	PROCESS OPTIONS
Groundwater	No Action / Limited Action:		
		No Action	
	No action	Site Reviews	Five-year review of site conditions
	Limited Action	Limited Action	
		Monitoring	Long-term monitoring and analysis of groundwater to assess contaminant migration
		Use Restriction	Well restrictions, NJDEP Classification Exception Area (CEA)
	Containment Actions:	Containment	
	Containment		Sheet Piling
			Slurry Walls
			Hydraulic Containment
Groundwater	Removal / Treatment Actions:		
	Removal / Treatment	Removal/Treatment	
		Removal	Extraction Wells
		In situ Treatment	*In situ* Funnel and Gate
			In situ Biodegradation
			In situ Chemical Oxidation
		Ex situ Treatment	Neutralization / pH Adjustment
			Chemical Precipitation
			Clarification
			Filtration
			Carbon Adsorption
			UV-Oxidation
			Ion Exchange

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TABLE 2-3 (Sheet 4 of 4)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS

ENVIRONMENTAL MEDIA	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES	PROCESS OPTIONS
			Reverse Osmosis Biological Treatment
Groundwater	Disposal / Discharge Actions:		
	Disposal / Discharge	Disposal / Discharge	
		Discharge	Discharge to Groundwater Discharge to Surface Water Discharge to Publicly Owned Treatment Works (POTW)

- There is a large Slag Disposal Area located in the westernmost portion of the site. The slag area has been addressed under the OU-3 FS and ROD; however, based on pre-design investigations, potential remedies for the Slag Disposal Area will be re-evaluated in this FS.

- Soils site-wide are contaminated with PAHs and inorganics with concentrations in excess of ARARs, TBCs and target risk ranges.

- Sediments in both Crafts Creek and the Delaware River are contaminated with PAHs and inorganics. Sediment areas requiring remediation were determined based on the risks posed to ecological receptors.

- Groundwater is impacted above NJ-GWQS for inorganics and low-level organics.

An initial screening of remedial technologies and process options is performed based on technical feasibility. Those options that are technically feasible are retained and further evaluated based on Effectiveness, Implementability, and Cost.

- Evaluation of process option effectiveness focuses on: 1) ability to process the estimated quantities of material and to meet contaminant reduction goals; 2) effectiveness of protecting human health and the environment during the construction and implementation phases; and 3) reliability of the technology with respect to contaminants and site conditions.

- Implementability refers to how easy it will be to employ this process option based on site and contaminant characteristics.

- At this stage, the cost evaluation is preliminary and relies upon engineering judgment and vendor-provided information to generate a relative cost of process options within a technology type.

2.4.2 Screening and Evaluation of Soil/Sediment Technologies and Process Options

In the following subsections, potential technologies for remediation of the contaminated soils and sediments are briefly described and summarized with the results of the screening and evaluation. For those technologies that were not retained for further evaluation, the rationale for their elimination is included. The screening evaluations for each identified technology are summarized in Table 2-4. The evaluation and selections of process options for technologies are presented in Tables 2-5 and 2-6, for soils and sediments, respectively.

2.4.2.1 No Action

No Action

No Action is not a category of technologies, but an option that does not include any remedial measures. No Action does allow for periodic reviews of the site and re-evaluation of the need for remedial action.

TABLE 2-4 (Sheet 1 of 8)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
INITIAL SCREENING OF SOIL/SEDIMENT REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	DESCRIPTION	TECHNICALLY FEASIBLE		CONCLUSION/COMMENTS
			Soil	Sediment	
1. No Action	• Site Reviews - Five-year reviews	The site and available data are reviewed to determine if remedial action is needed.	Yes	Yes	Provides baseline against which other remedial technologies can be compared. Required for consideration by NCP.
2. Limited Action	• Monitoring	Long-term monitoring and analysis to assess site contamination.	Yes	Yes	Required for effective implementation of Limited Action.
	• Access Restrictions - Fencing	Access restricted by fencing the contaminated area.	Yes	No	Required for effective implementation of Limited Action.
	• Institutional Controls - NJDEP DER	Land use restrictions would be specified in a DER for the site under NJDEP regulations.	Yes	Yes	Required for effective implementation of Limited Action.
	• Erosion Control/ Stormwater Management	Erosion control/stormwater management achieved by dust suppression, site re-grading, and seeding or vegetation	Yes	No	Required for effective implementation of Limited Action.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
INITIAL SCREENING OF SOIL/SEDIMENT REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	DESCRIPTION	TECHNICALLY FEASIBLE		CONCLUSION/COMMENTS
			Soil	Sediment	
3. Containment					
	• Capping				
	- Soil cover	Contaminated soils or sediments are covered with a soil cover.	Yes	Yes	Reduces direct contact risks.
	- Clay cap	Contaminated soil is covered with a low permeability clay layer.	Yes	No	Reduces direct contact risks and infiltration. Applicable and feasible for soil. Not be applicable/feasible for sediments since it would not support the benthic community, wetland value, etc. and it would alter the wetland hydrology.
	- Asphalt cap	Contaminated soil is covered with a gravel sub-base and a layer of asphalt.	Yes	No	Reduces direct contact risks and infiltration. Applicable and feasible for soil. Not be applicable/feasible for sediments since it would not support the benthic community, wetland value, etc. and it would alter the wetland hydrology.
	- Concrete cap	Contaminated soil is covered with a layer of concrete.	Yes	No	Reduces direct contact risks and infiltration. Applicable and feasible for soil. Not be applicable/feasible for sediments since it would not support the benthic community, wetland value, etc. and it would alter the wetland hydrology.
	- Synthetic cap	Contaminated soil is covered with a synthetic geotextile material.	Yes	No	Reduces direct contact risks and possibly reduces infiltration. Applicable and feasible for soil. Not be applicable/feasible for sediments since it would not support the benthic community, wetland value, etc. and it would alter the wetland hydrology.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
INITIAL SCREENING OF SOIL/SEDIMENT REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	DESCRIPTION	TECHNICALLY FEASIBLE		CONCLUSION/COMMENTS
			Soil	Sediment	
3. Containment (Cont'd)	- Multiple layer cap	Contaminated soil is covered with a composite cap consisting of a vegetative layer, a drainage layer, and a low permeability layer with a permeability $<1x10^{-7}$ cm/sec.	Yes	No	Reduces direct contact risks and infiltration of storm water. Applicable and feasible for soil. May not be applicable/feasible for sediments since it would not support the benthic community, wetland value, etc.
	• Stormwater/Erosion Control	Stormwater/erosion central measures such as riprap, drainage ditches, silt fences, etc. are employed to direct storm/surface water around areas of contamination thereby preventing erosion and spread of contaminated material.	Yes	Yes	Used in conjunction with capping and excavation options.
4. Removal/Treatment					
	• Removal				
	- Excavation	Excavation involves removing contaminated soil using backhoes, bulldozers, front end loaders, etc.	Yes	Yes	Required component of many potential process options.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
INITIAL SCREENING OF SOIL/SEDIMENT REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	DESCRIPTION	TECHNICALLY FEASIBLE		CONCLUSION/COMMENTS
			Soil	Sediment	
4. Removal/Treatment (Cont'd)	- Dredging	Dredging involves removing contaminated material that is underwater (sediments) using a clamshell, suction, bucket, or dipper dredge.	N/A	Yes	Required component of many potential process options.
	• Physical Treatment				
	- Screening	Contaminated material is separated according to size in order to facilitate further treatment.	Yes	Yes	Required component of many treatment/ disposal options.
	- Solidification/ Stabilization	Contaminants are immobilized by mixing soil/sediments with cement-based additives (solidification) or chemical agents (stabilization).	Yes	Yes	Primary application is for inorganic contaminants. Also effective for low semi-volatile concentrations present on-site.
	- Soil washing/acid leaching	Contaminated materials are mechanically scrubbed *ex situ* to remove contaminants. The process of acid leaching increases soluble forms of metals to facilitate removal.	Yes	Yes	Primary application is for inorganic contaminants; however, also potentially effective for low concentrations of semi-volatiles present on-site.
	- Dewatering	Excavated soil below the water table and dredged sediments are dewatered prior to disposal in order to reduce their volume.	Yes	Yes	Required component of many treatment/disposal options.

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TABLE 2-4 (Sheet 5 of 8)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
INITIAL SCREENING OF SOIL/SEDIMENT REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	DESCRIPTION	TECHNICALLY FEASIBLE		CONCLUSION/COMMENTS
			Soil	Sediment	
4. Removal/Treatment (Cont'd)	• Thermal Treatment				
	- Incineration	Incineration is a thermal destruction method for all forms of organic contamination involving treatment at high temperatures (>1,000°F).	No	No	Incineration would be effective in treating semi-volatiles present on-site; however, not effective for inorganics which are the primary contaminants of concern.
	- Low/High temperature thermal desorption	Thermal desorption is a thermal (400°F to 900°F) stripping process which promotes volatilization of organics from soil to air	No	No	Thermal desorption would be effective in treating low concentrations of semi-volatiles present on-site; however, not feasible for inorganics which are the primary contaminants of concern.
	- Vitrification	Vitrification is a process whereby contaminated soil is converted into a glassy substance by melting at a high temperature.	No	No	Not feasible due to high costs and site conditions, such as the proximity to groundwater and the Delaware River, the small areas of soil to be remediated between buildings, and the potential to volatilize lead.
	• Chemical Treatment				
	- Solvent extraction	Contaminants are removed from solid media by mixing with solvent.	No	No	Solvent extraction would be effective in treating semi-volatiles present on-site; however, a solvent would not be effective in removing inorganics which are the primary contaminants of concern.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
INITIAL SCREENING OF SOIL/SEDIMENT REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	DESCRIPTION	TECHNICALLY FEASIBLE Soil	TECHNICALLY FEASIBLE Sediment	CONCLUSION/COMMENTS
4. Removal/Treatment (Cont'd)					
	• Biological Treatment				
	- Biodegradation (ex situ)	*Ex situ* biological treatment using native microbes or selectively adapted bacteria to degrade a variety of organic compounds in the presence (aerobic) or absence (anaerobic) of oxygen. *Ex situ* biodegradation takes place following soil/sediment removal.	No	No	Biodegradation is feasible for treating semi-volatiles; however, not feasible for inorganics which are the primary contaminants of concern.
	• *In situ* Treatment				
	- Soil flushing	In-situ soil flushing is the in-place extraction of organic or inorganic compounds from the soil by passing appropriate extractant solutions to dissolve or mobilize contaminants.	No	No	Soil flushing is not feasible due to the heterogeneity of the soil and slag. Also, sediments are not amenable to *in situ* technologies.
	- Solidification/ Stabilization	Contaminants are immobilized in-place by mixing soil/sediments with cement-based additives (solidification) or chemical agents (stabilization).	Yes	No	Feasible for soil that is contaminated with inorganics, but not amenable to sediments since it would alter the wetland hydrology.

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TABLE 2-4 (Sheet 7 of 8)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
INITIAL SCREENING OF SOIL/SEDIMENT REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	DESCRIPTION	TECHNICALLY FEASIBLE Soil	TECHNICALLY FEASIBLE Sediment	CONCLUSION/COMMENTS
4. Removal/Treatment (Cont'd)					
	- Biodegradation (in situ)	*In situ* biological treatment process that is performed in place, using native microbes or selectively adapted bacteria to degrade a variety of organic compounds.	No	No	Biodegradation is feasible for treating semi-volatiles; however, not feasible for inorganics which are the primary contaminants of concern.
	- Phyto-remediation	Hybrid plants are used to extract contaminants from the soil.	No	No	Potentially effective treatment for primary contaminants of concern and PAHs; however, cannot be applied effectively to subsurface contamination. Also, unlikely to support vegetative growth in slag area. This technology is not currently developed for underwater environments.
5. Disposal					
	• Disposal				
	- Off-Site Landfill	The disposal of excavated soil at a facility permitted to accept such waste.	Yes	Yes	Potentially feasible; however, soil/ sediment may require treatment prior to disposal.
	- On-Site Backfill	The placement of the treated soil/sediment at the site as backfill.	Yes	Yes	Potentially feasible; however, soil/ sediment needs to meet backfill requirements.

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TABLE 2-4 (Sheet 8 of 8)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
INITIAL SCREENING OF SOIL/SEDIMENT REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	DESCRIPTION	TECHNICALLY FEASIBLE		CONCLUSION/COMMENTS
			Soil	Sediment	
	- On-Site Disposal	The disposal of excavated soil and/or sediments in an on-site landfill.	No	Yes	On-site disposal is not feasible due to the shallow water table, proximity to surface water, and inappropriate location for landfill construction. Also, if soils are treated to LDRs, they may be suitable for use as backfill. Above-ground storage facilities would not allow for reuse or redevelopment of the property. Because sediment contamination may be lower than soil cleanup criteria, this option may be viable.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
EVALUATION OF SOIL PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST
1. No Action	• Site Reviews*			
	- Five-year reviews	Low (1)	High (2)	Low
2. Limited Action	• Monitoring*			
	- Periodic inspections	Low	High	Low
	• Access Restrictions*			
	- Fencing	Low	High	Low
	• Institutional Controls*			
	- NJDEP DER	Low	High	Low
	• Erosion Control/Stormwater Management*	Low	High	Low
3. Containment	• Capping			
	- Soil Cover*	Low	High	Low
	- Clay Cap*	Moderate(3)	High	Low
	- Asphalt Cap*	Moderate	High	Low

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TABLE 2-5 (Sheet 2 of 3)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
EVALUATION OF SOIL PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST
3. Containment (Cont'd)				
	- Concrete Cap	Moderate	High	Moderate
	- Synthetic Cap	Moderate	High	Moderate
	- Multiple Layer Cap	High	Moderate	High
	• Stormwater/Erosion Control*	Low	High	Low
4. Removal/Treatment				
	• Removal			
	- Excavation*	High	High	Low
	• Physical Treatment			
	- Screening*	High	High	Low
	- Solidification/Stabilization	Moderate	High	Moderate
	- Soil washing/acid leaching*	High	Moderate	High
	- Dewatering	High	High	Low

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TABLE 2-5 (Sheet 3 of 3)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
EVALUATION OF SOIL PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST
4. Removal/Treatment (Cont'd)				
	• *In situ* Treatment			
	- Solidification/Stabilization*	High	Moderate	Moderate
5. Disposal	• Disposal			
	- Off-site Landfill*	High	High	High
	- On-site Backfill*	High	High	Moderate

Notes:

* Designates representative process options selected for development of alternatives in Sections 3 and 4.

() Low Effectiveness - not very effective
Low Implementability - difficult to implement
Low Cost - not very expensive

() High Effectiveness - very effective
High Implementability - easy to implement
High Cost - expensive

() Moderate Effectiveness - somewhat effective
Moderate Implementability - can be implemented
Moderate Cost -reasonable cost
Moderate ratings are also used to indicate uncertainty with respect to the evaluation of the criteria.

Note that these ratings represent a broad range and that the process options are rated relative to each other within each technology category.

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TABLE 2-6 (Sheet 1 of 3)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
EVALUATION OF SEDIMENT PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST
1. No Action	• Site Reviews*			
	- Five-year reviews	Low [(1)]	High [(2)]	Low
2. Institutional Controls	• Monitoring*			
	- Monitor and analyze sediment	Low	High	Low
	• Institutional Controls*			
	- NJDEP DER	Low	High	Low
3. Containment				
	• Capping			
	- Soil Cover*	Low	High	Low
	• Stormwater/Erosion Control			
	- Riprap/trenches/culverts*	Low	High	Low

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
EVALUATION OF SEDIMENT PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST
4. Removal/Treatment				
	• Removal			
	- Excavation*	High	High	Low
	- Dredging*	High	Moderate (3)	Moderate
	• Physical Treatment			
	- Screening*	High	High	Low
	- Solidification/Stabilization	Moderate	High	Moderate
	- Soil washing/acid leaching	High	Moderate	High
	- Dewatering*	High	High	Low

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TABLE 2-6 (Sheet 3 of 3)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
EVALUATION OF SEDIMENT PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST
5. Disposal	• Disposal			
	- Off-site Landfill*	Moderate	High	High
	- On-site Backfill*	Moderate	High	Moderate

Notes:

* Designates representative process options selected for development of alternatives in Sections 3 and 4.

(1) Low Effectiveness - not very effective
Low Implementability - difficult to implement
Low Cost - not very expensive

(2) High Effectiveness - very effective
High Implementability - easy to implement
High Cost - expensive

() Moderate Effectiveness - somewhat effective
Moderate Implementability - can be implemented
Moderate Cost - reasonable cost
Moderate ratings are also used to indicate uncertainty with respect to the evaluation of the criteria.

Note that these ratings represent a broad range and that the process options are rated relative to each other within each technology category.

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Description: No Action is not a category of technologies, but a group of activities which can be used to address the soil and sediment contamination problem when no remedial measures will be implemented. The No Action alternative will be developed later in this report as required by the NCP. The No Action approach includes periodic site reviews.

Initial Screening: The baseline human health risk assessment indicates that the contaminated soil and sediments associated with the site present potential carcinogenic and noncarcinogenic risks. The existing fence bordering the RSC is not completely intact and thus potential exposure to the contaminated soil and sediments may exist. Reduction in toxicity, mobility, or volume of contaminated soil and sediments would be left to natural attenuation processes, since no treatment would be implemented. Due to the nature of the contaminants (i.e., predominantly inorganics), biodegradation is not considered to contribute to the attenuation of contamination at the site, and natural attenuation refers only to physical processes (e.g., leaching, dilution, etc.). However, No Action is retained through the detailed evaluation as a baseline comparison for other alternatives.

2.4.2.2 Limited Action

Limited Action is a category of technologies which includes restrictions to minimize exposure to the contamination. The Limited Action technologies include site monitoring, access restriction (fences), institutional controls (Declaration of Restrictions), and erosion control/stormwater management.

Monitoring

Description: Long-term monitoring includes periodic site inspections and sampling and analyses of contaminated sediments for assessing contaminant migration, detecting any changes in the environment, identifying any toxic or mobile transformation products, and verifying attainment of remediation objectives.

Initial Screening: Long-term monitoring is a common support activity for achieving RAOs and implementing institutional controls. Therefore, it was retained for further evaluation for soil and sediment.

Access Restrictions

Description: Access to the site and use would be restricted by repairing the existing fence with warning signs around the areas containing contamination. The existing security guards service at the main entrance to the site will be continued. The security guards would also patrol the site at regular intervals.

Initial Screening: Fencing around the contaminated soil areas would effectively prevent exposure to the contaminated soil. However, the site perimeter is large and the fence could be breeched at remote locations. Regular rounds performed by the security guards could help remove individuals in the event that they did trespass on site property. The contaminants would not be removed and would remain on-site at levels exceeding ARARs and TBCs. However, fencing is the most effective action to prevent site access that could be easily implemented. The potential for access to contaminated sediment still remains in absence of access restrictions. Therefore, this option was retained for further consideration for soil.

Declaration of Environmental Restrictions

Description: With this technology, land use restrictions would be specified in a DER for the property under NJDEP regulations. This would restrict the land use and would be specified in the real estate transactions of the property. Examples would include limitations on excavation at the site.

Initial Screening: A DER or some other similar use restriction would be required as a final step in numerous process options. A DER was retained for further consideration as a process option for soil and sediment.

Erosion Control/Stormwater Management

Description: Erosion control and stormwater management are support activities that can be easily achieved by dust suppression, site re-grading, stormwater conveyance system, and seeding or vegetation.

Initial Screening: Since erosion control/stormwater management are required for the effective implementation of Limited Action and other remedial actions, this process option was retained for further consideration for soil. It was, however, eliminated from further consideration for sediment.

2.4.2.3 Containment

Containment is a remedial action providing isolation of contaminant source soil and sediments from potential receptors and/or uncontaminated media. Capping technologies can be used to contain contaminated soil and sediments, minimize human exposure to soil, reduce leaching of contaminants from the soil to groundwater, and/or minimize exposure of ecological receptors to contaminated sediments. Capping of contaminated soil and/or contaminated sediments could be achieved by utilizing any one or a combination of soil caps, clay caps, asphalt caps, concrete caps, synthetic caps, and multiple layer caps.

Soil Cap

Description: A soil cap can be installed over contaminated soil or sediments to prevent direct contact with contaminants. A soil cap would have a high permeability relative to clay, and would allow percolation of surface water, runoff, etc.

Initial Screening: Soil caps are susceptible to erosion from climatic and storm forces which can be mitigated with a properly maintained vegetative cover. Soil caps are also susceptible to settling, ponding of liquids, and naturally occurring invasions by burrowing animals and deep rooted vegetation if not properly maintained. However, a soil cover would be effective in reducing direct contact with contaminated site-wide soils. This option was retained for further consideration for soil and sediment.

Clay Cap

Description: Clay caps/layers are commonly used as cover for lands which contain both hazardous and nonhazardous wastes. Bentonite, a natural clay with high swelling properties, is often mixed with on-site soil and water to produce a low permeability layer. A low permeability clay cap would not only physically isolate the source, but also reduce the potential for leaching of contaminants to groundwater by creating a low permeability barrier.

Initial Screening: Clay, which consists of fine material, is susceptible to erosion from climatic and storm forces which can be mitigated with a properly maintained vegetative cover. Proper particle distribution is essential to create a low permeability cap. Clay caps are also susceptible to cracking, settling, ponding of liquids and naturally occurring invasions by burrowing animals and deep rooted vegetation if not properly maintained. A clay cap would be effective in achieving RAOs for soil including reducing direct contact with contaminated soils. This option was retained for further consideration for soil contamination.

A clay cap would also be effective in achieving RAOs for sediments including reducing risks to ecological receptors. However, a clay cap would not provide a suitable environment for the benthic organisms currently present in the sediments. A clay cap cannot be placed in wetland areas. Therefore, this option was not retained for further consideration for sediment.

Asphalt Cap

Description: An asphalt cap would consist of graded soil surface and a gravel sub-base, with asphalt paving as a final cover. The cap minimizes wind and rain erosion, preserves slope stability, provides protection from the elements for layers below it, and provides an effective component for the site's storm water management program.

Initial Screening: An asphalt cap provides a low permeability cover to contain contaminated areas. It is less susceptible to erosion from climatic and storm forces than a soil or clay cap. An asphalt cap is subject to cracking and settling if not properly maintained. However, it would be effective in achieving RAOs for soil including reducing direct contact with contaminated soils. This option was retained for further consideration for soils. Since it does not support the benthic community or wetlands, it was eliminated from further consideration for sediments.

Concrete Cap

Description: A concrete cap would consist of graded soil surface with concrete as a final cover. The cap minimizes wind and rain erosion, preserves slope stability, and provides protection from the elements for layers below it. A concrete cap is not a totally impermeable boundary to water infiltration, but is designed to significantly reduce infiltration.

Initial Screening: A concrete cap provides a low permeability cover to contain contaminated areas. It is less susceptible to erosion from climatic and storm forces than a soil or clay cap. A concrete cap is subject to cracking and settling if not properly maintained. However, it would be effective in achieving RAOs for soil including reducing direct contact with contaminated soils. This option was retained for further consideration for soils. Since it does not support the benthic community or wetlands, it was eliminated from further consideration for sediments.

Synthetic Cap

Description: Flexible synthetic membrane caps are made of polyvinyl chloride (PVC), high density polyethylene (HDPE), chlorinated polyethylene (CP), ethylene propylene rubber, butyl rubber, Hypalon neoprene (synthetic rubber) and elasticized polyolefin. Thin sheets are available in sections of variable width and the sheets are overlain and spliced in the field (according to manufacturer's specifications). Special adhesives and sealants are used to ensure cap integrity.

Initial Screening: Synthetic caps are labor intensive relative to clay caps since sealing materials require special field installation methods. Careful consideration should be given in selection of the material of the synthetic liners to withstand the chemicals present. In addition to these disadvantages, the integrity of synthetic liners can be damaged by uneven (differential) settling and invasion by burrowing animals and deep rooted plants. A synthetic membrane cap would be effective in achieving remedial action objectives for soil in reducing direct contact with contaminated media. This option was retained for further consideration for soils. Since it does not support the benthic community or wetlands, it was eliminated from further consideration for sediments.

Multiple Layer Cap

Description: The multiple layer cap is a combination of two or more of the single layer capping technologies. The disadvantage of one can be compensated by the advantage of another. Most caps recommended for hazardous waste projects are multilayer caps such as a three layered system. Contaminated soil is covered with a composite cap consisting of a vegetative layer, a drainage layer, and a low permeability layer with a permeability $<1 \times 10^{-7}$ cm/sec.

Initial Screening: The performance of a properly installed, multilayered cap is generally excellent. However, over time, the integrity of the low permeability synthetic layer becomes uncertain and should be investigated regularly. A multiple layer cap would be effective in achieving RAOs for soil including reducing direct contact with contaminated soils. Therefore, this option was retained for further consideration for soils. Since it does not support the benthic community or wetlands, it was eliminated from further consideration for sediments.

Stormwater/Erosion Control

Description: Stormwater and erosion control is utilized for diverting surface water runoff around contamination as a way of reducing contaminant migration. Methods available include riprap, silt fences, trenches, and culverts.

Initial Screening: Stormwater/erosion control may be required in conjunction with one or more technology and process options as a support activity. This process option was retained for further consideration for soil and sediments.

2.4.2.4 Removal

This process involves physical removal of contaminated soil and sediments, usually with the intention of subsequent treatment and/or disposal. This category includes excavation and dredging and is a preliminary or support technology as a part of alternatives which first require removal of the contaminated media.

Excavation

Description: Excavation refers to the use of construction equipment such as backhoes, bulldozers, front end loaders, and draglines that are typically used on land to excavate and handle contaminated soil.

Initial Screening: Excavation would be required as the initial material handling step in numerous process options. Excavation was retained for further consideration as a process option for soil and sediments.

Dredging

Description: Dredging involves removing contaminated material that is underwater (sediments) using a clamshell, suction, bucket, or dipper dredge.

Initial Screening: Dredging would be required as the initial material handling step in more than one alternative. This conventional process option can be applied to the Back Channel and to Crafts Creek. The quantity of sediments requiring dredging depends on the remedy selected, i.e., less material requires dredging if capping is selected for non-wetland sediment areas. Dredging was retained for further consideration as a process option for sediments.

2.4.2.5 Treatment

Treatment technologies are used to change the physical or chemical state of a contaminant or to destroy the contaminant completely to reduce volume, toxicity or mobility of the contaminant. The categories of technologies that are included are physical treatment, thermal treatment, chemical treatment, biological treatment, and *in situ* treatment.

Physical Treatment

Screening

Description: Contaminated material is separated according to size in order to facilitate further treatment. Screens of different size mesh are used to accomplish this.

Initial Screening: The screening technology is an implementable process as a pretreatment technology only. Screening is retained for further consideration as a process option.

Solidification/Stabilization

Description: Stabilization is a process whereby contaminated soils are converted into a stable cement type matrix in which contaminants are bound or trapped and become immobile. Silicates can stabilize contaminants such as metals and some organics in soil. It has been demonstrated that chemical fixation products of certain silicate-base mixtures can meet the hazardous waste TCLP tests.

Initial Screening: This process would be effective for the contaminated soil. This technology would immobilize contaminants in the soil matrix and would require long-term monitoring at the point of disposal. Stabilization can be done either by on-site mobile units or at off-site commercial facilities. This technology can be used for fixation of contaminants present in the site soil and therefore was retained for further evaluation for soil and sediment.

Soil Washing/Acid Leaching

Description: Contaminated materials are mechanically scrubbed ex-situ to remove contaminants. The process of acid leaching converts metals to soluble forms to facilitate removal. Soil is excavated and treated with solution in a soil washer. The spent soil washing/acid leaching solution containing contaminants would be further treated on-site or off-site before disposal.

Initial Screening: The most promising soil washing/acid leaching application is its use in the extraction of heavy metals; however, it is also potentially effective in removing low concentrations of PAHs present on-site. With proper treatability studies, design and implementation, this technology should be able to reduce concentrations in soil to meet treatment goals. A large volume of wastewater will be generated which would then require management via treatment and discharge. Soil washing/acid leaching was retained for further consideration for soil and sediment.

Dewatering

Description: The water content of sediments (or soils) are reduced to minimize the final volume of solids requiring disposal. Volume reduction can be accomplished using centrifuge vacuum filtration, a belt filter or a plate and frame filter press. Vacuum filtration is generally conducted using a horizontal rotating drum covered with cloth filter medium. The plate and frame filter is operated in batch rather than continuous mode and is suitable for sediment dewatering. A variation of this technology is the belt filter press which can be operated continuously.

Initial Screening: Application of this treatment method is anticipated to be necessary prior to disposal of sediments. Therefore, dewatering was retained as a feasible technology for further evaluation for soil and sediment.

Thermal Treatment

Thermal treatment is a technology category which utilizes thermal energy to treat contaminated media to reduce the volume, toxicity or mobility of contaminants. The process options included in this technology category are incineration, thermal desorption, and vitrification. Thermal treatment processes are only applicable to organic contamination.

Incineration

Description: Incineration is a thermal destruction method which can be used to destroy combustible waste materials including organic contaminants in soils. Incineration systems such as multiple hearth, rotary kiln, infrared and fluidized bed can treat highly-contaminated soils at high temperatures (1200°F to 1800°F in the primary chamber and 1400°F to 2400°F in the secondary chamber). Infrared incineration systems are used primarily for solids or sludges.

Initial Screening: High temperature incineration is suitable for removal of high concentrations of organics in contaminated soils. The off-gas could potentially require the use of air pollution control devices. The residue will contain inorganics that would require additional treatment. Incineration was eliminated from further consideration due to high concentrations of inorganics present.

Low/High Temperature Thermal Desorption

Description: The thermal desorption technology is a thermal stripping process. Prepared soils are introduced into the enclosed heated chamber using a heated screw or belt conveyor. Direct or indirect heating methods are used to volatilize organics from the soil. The off-gas containing the thermally stripped compounds is then combusted in an afterburner, adsorbed in a carbon adsorption unit or treated by catalytic oxidation designed to ensure complete removal of these compounds. Typical operating temperatures for thermal stripping of organics are 400°F to 900°F.

Initial Screening: Thermal stripping is similar to the primary chamber of incineration technology but operates at lower temperatures. This technology can be performed either by on-site mobile units or at off-site commercial facilities. This technology is applicable and effective for removal of semi-volatile organics in contaminated soils at the site, but was eliminated from further consideration due to high concentrations of inorganics.

Vitrification

Description: Vitrification is a thermal treatment process intended to provide stabilization of chemically contaminated soil. Vitrification destroys organic compounds by pyrolysis and immobilizes inorganic contaminants such as heavy metals into a glass-like material. Vitrification includes a power supply system, off-gas containment, electrode support hood, off-gas treatment system, and process control station.

Initial Screening: Vitrification is near commercialization for low level radioactive waste stabilization, heavy metal fixation, and hydrocarbon destruction. However, due to site conditions in the contaminated areas (very large area), this technology would be impractical to implement. Vitrification is also energy intensive and very costly. Vitrification is usually only used for highly toxic wastes and was therefore eliminated from further consideration.

Chemical Treatment

Chemical treatment is a category of technologies that utilize chemical reactions or changes of chemical properties in treating contaminants to reduce their volume, toxicity or mobility. This category of technologies includes solvent extraction.

Solvent Extraction

Description: Solvent extraction involves the separation of contaminants from the soil by contacting it with solvents. Soil is excavated and treated with extractant solution in a soil washer. The spent solvent extraction solution containing contaminants would be further treated on-site or off-site before disposal. The soil would be rinsed, neutralized, if necessary, and used as backfill.

Initial Screening: Solvent extraction would be effective in removing semi-volatiles present on-site; however, an organic solvent would not be effective in removing inorganic contaminants of concern. A large volume of wastewater would be generated which would then require management via treatment and discharge. Therefore, solvent extraction was eliminated from further evaluation.

Biological Treatment

Biodegradation

Description: On-site biological treatment involves the use of native microbes or selectively adapted bacteria to degrade a variety of organic compounds. The biological processes usually involve the addition of microbes, nutrients, oxygen (aerobic bioreclamation only) and recirculation of contaminated groundwater. The applicability of a bioreclamation approach is determined by the biodegradability of the organic contaminants, and environmental factors affecting microbial activity. Bioremediation can be performed *in situ* (in place), on-site (after excavation), or using land farming treatment methods. Biodegradation can be either aerobic or anaerobic depending upon the contaminants present on the site.

Initial Screening: On-site biodegradation is a developmental technology for hazardous waste cleanup that requires extensive bench and pilot-scale testing to verify its effectiveness. While aerobic biodegradation has been demonstrated to be effective on some organics, it is not applicable for inorganic contamination. Due to wide-spread inorganic contamination, biodegradation was eliminated from further consideration.

In Situ Treatment

In situ treatment is a technology category in which contaminated soil is treated "in place" without excavation. The technologies evaluated in this category are soil flushing, stabilization, biodegradation, and phyto remediation.

In Situ Soil Flushing

Description: Soil flushing is the *in situ* extraction of inorganic or organic compounds from soil by passing appropriate extractant solutions through the soils to dissolve or solubilize contaminants. The area to be treated must be isolated by vertical and horizontal groundwater containment barriers. Water or an aqueous solution is flooded or injected into the area of contamination and the contaminated elutriate is collected at the surface for removal, recirculation, on-site treatment, or reinjection. During elutriation, sorbed contaminants are mobilized into solution by the dissolution process, formation of an emulsion, or by chemical reaction with the flushing solution. These solutions may include water, surfactants, acids or bases, chelating agents, oxidizing and reducing agents.

Initial Screening: A large volume of wastewater would be generated due to multiple flushing steps to treat the contaminants of concern and would require collection and management via treatment and discharge. Significant hydraulic controls would be required for the very large area of contamination present at RSC. In addition, soil flushing is not amenable to the heterogeneous soil and slag material. Therefore, *in situ* soil flushing was eliminated from further consideration as a process option.

In Situ Solidification/Stabilization

Description: *In situ* solidification/stabilization is a process whereby contaminated soils are converted in-place into a stable cement type matrix in which contaminants are bound or trapped and become immobile. Silicates can stabilize contaminants such as metals and some organics, including low concentrations of PAHs. It has been demonstrated that chemical fixation products of certain silicate-base mixtures do not leach metals and most organics.

Initial Screening: This process would be effective for treatment of the contaminated soil. This technology would immobilize contaminants in the soil matrix and would require long term monitoring of the site. This technology can be used for fixation of contaminants present in the site soil and therefore was retained for further evaluation as a process option for soil.

In Situ Biodegradation

Description: Biological treatment involves the use of native microbes or selectively adapted bacteria to degrade a variety of organic compounds. The biological processes usually involve the addition of microbes, nutrients, and oxygen (aerobic bioreclamation only), as well as, the recirculation of contaminated groundwater. The applicability of a bioreclamation approach is determined by the biodegradability of the organic contaminants, and environmental factors affecting microbial activity.

In situ biodegradation is performed in place. Biodegradation can be either aerobic or anaerobic depending upon the contaminants present on the site.

Initial Screening: *In situ* biodegradation is not a widely employed technology for hazardous waste cleanup which requires extensive bench and pilot-scale testing to verify its effectiveness. While biodegradation has been demonstrated to be effective on some organics, it is not applicable for inorganic contamination. Due to high concentrations of inorganic contaminants, biodegradation was eliminated from further consideration.

Phytoremediation

Description: Phytoremediation is the use of hybrid plants to extract contaminants from contaminated media. Specially selected plants known to be effective for such purposes are planted and allowed to grow. As the plants grow they absorb contaminants. The plants are then harvested and either incinerated or composted.

For example, the Indian mustard plant has been the subject of much investigation into its potential for extracting contaminants from soil. It has been shown to be effective in absorbing high amounts of lead, chromium, copper, and other heavy metals, as well as PAHs, into its stalks and leaves. The roots typically reach about 20 inches into the ground. If the plants are incinerated after harvest, they leave behind an ash that is valuable for its content of metal, which may exceed 40 percent.

Initial Screening: This technology is effective in removing metals and PAHs and is low in cost. Due to site conditions including tightly packed surface soils and the large area, certain areas would require special site preparation. In addition, this process option would not be effective for treating contamination at depths of up to 8 to 10 feet bgs. This process option could also be lengthy as it may be necessary to harvest several crops before cleanup criteria are met. Therefore, phytoremediation was eliminated from further consideration.

2.4.2.6 Disposal Technologies

This category of remedial technologies refers to disposal of contaminated soil, with or without any treatment. The remedial technologies are off-site disposal, on-site disposal, and/or on-site backfilling.

Off-Site Landfill Disposal

Description: Contaminated material would be excavated, treated on or off-site (if necessary), and then be disposed of at an existing permitted landfill. This provides a possible solution to the disposal problem, but unit costs may be high if material is not treated on-site prior to transportation and disposal.

Initial Screening: In addition to high disposal costs, there may be limitations on the types of contaminated soil or sediment that can be disposed of at these facilities. However, the use of an off-site landfill may be required as a component of alternatives requiring disposal of soil or sediment. The off-site landfill option was retained for further evaluation for soil and sediment.

On-Site Backfilling

Description: Contaminated material would be excavated, treated on-site as necessary, and then backfilled in the previously excavated areas.

Initial Screening: The treated soil would be redeposited to fill the excavation area and the excess soil would be used at the site to grade the surface; however, the soil would have to be treated to meet backfilling criteria. The level of the land and the drainage pattern would likely be altered as soon as the site restoration is completed. Therefore, this technology was retained for further consideration as a process option for soil and sediment.

On-Site Disposal

Description: Contaminated material would be excavated, treated on-site, and then be disposed of in an on-site landfill.

Initial Screening: Due to the shallow water table, proximity to surface water, and inappropriate location for a landfill, the on-site disposal option was eliminated from further consideration for soil. Because sediment contaminant levels may be lower than soil cleanup criteria, this may be a viable option and is retained for further evaluation.

2.4.3 Screening and Evaluation of Groundwater Technologies and Process Options

In the following subsections, potential groundwater remedial technologies are briefly described and summarized with the results of the screening and evaluation. For those technologies which were not retained, the rationale for their elimination is included. The screening evaluations for each identified groundwater technology is summarized in Table 2-7. The evaluation and selection of process options for groundwater technologies are presented in Table 2-8.

2.4.3.1 No Action

No Action

Description: No Action is not a category of technologies but a group of activities which can be used to address the contaminated groundwater when no remediation measures will be implemented. The No Action approach includes performing five-year reviews to assess future remedial actions if deemed necessary.

Initial Screening: This approach would not provide any remedial action. Although it will be shown that the No Action alternative would not meet remedial objectives, it will be retained throughout the detailed evaluation as a baseline for comparison with other alternatives.

2.4.3.2 Limited Action

Limited Action is a category of technologies which includes restrictions to minimize exposure to the contamination. The Limited Action technologies include long-term monitoring, and use restrictions (NJDEP CEA).

TABLE 2-7 (Sheet 1 of 6)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
INITIAL SCREENING OF GROUNDWATER REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	DESCRIPTION	TECHNICALLY FEASIBLE	CONCLUSION / COMMENTS
1. No Action	No Action			
	Site Reviews	Five-year review of site conditions	Yes	No Action is required for baseline comparison.
2. Limited Action	Institutional Controls			
	Monitoring	Long-term monitoring	Yes	Sampling and analysis of long-term monitoring data is used to assess contaminant migration.
	Use Restrictions	Well restrictions CEA (Classification Exception Area)	Yes	Exposure to contaminated groundwater is controlled by restricted use.
3. Containment	Containment			
	Sheet Piling	Sheet piles are driven into soil to create a barrier which inhibits migration of groundwater.	Yes	Most effective when it can be keyed into a low permeability bottom layer.

TABLE 2-7 (Sheet 2 of 6)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
INITIAL SCREENING OF GROUNDWATER REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	DESCRIPTION	TECHNICALLY FEASIBLE	CONCLUSION / COMMENTS
3. Containment (Cont'd)	Slurry Walls	Soil is shored, trenched, and filled with a bentonite-water mixture to create a barrier and inhibit groundwater migration.	Yes	Most effective when they can be keyed into a confining clay or bedrock layer and where groundwater does not move rapidly.
	Hydraulic Containment	Utilizes a line of extraction wells to pump out site groundwater as it flows toward the site boundary; this water is then treated & discharged.	Yes	Relies upon the creation of overlapping capture zones to prevent groundwater flow past the wells; results in excessive amount of groundwater, requiring treatment and disposal. May be used in conjunction with sheet pile or slurry wall.
4. Removal	Removal			
	Extraction Wells	Contaminated groundwater is extracted through screened wells within the aquifers.	Yes	Extracted groundwater must be treated and disposed; feasible for groundwater restoration.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
INITIAL SCREENING OF GROUNDWATER REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	DESCRIPTION	TECHNICALLY FEASIBLE	CONCLUSION / COMMENTS
5. Treatment	Treatment			
	In situ Treatment			
	In situ Funnel and Gate	Uses a vertical barrier to contain groundwater and funnels it towards an open reactive window to some type of *in situ* treatment media (e.g., adsorbers, resin, filters, biological treatment).	No	Excessive maintenance of the in-situ treatment unit is required due to the high metals contamination and subsequent fouling.
	In situ Biodegradation	Microbes degrade organic compounds into end products of carbon dioxide and water.	No	Biodegradation is ineffective for treatment of heavy metals.
	In situ Chemical Oxidation	Uses an injected chemical reagent to break down organics into carbon dioxide and water.	No	Best applied to groundwater with organics; not effective for metals.

TABLE 2-7 (Sheet 4 of 6)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
INITIAL SCREENING OF GROUNDWATER REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	DESCRIPTION	TECHNICALLY FEASIBLE	CONCLUSION / COMMENTS
5. Treatment (Cont'd)	*Ex situ Treatment*			
	Neutralization / pH Adjustment	Adjusts the groundwater stream to an appropriate pH level for treatment/discharge via caustic or acid addition.	Yes	Feasible for altering the acidity or alkalinity required for discharge.
	Chemical Precipitation	Addition of a precipitating agent to the point where the lowest solubility of compounds to be removed is reached.	Yes	Difficulties arise since all metals do not have a common pH at which they precipitate; highly effective for dissolved metals removal.
	Clarification	Removes settleable suspended solids to produce a clear waste stream.	Yes	Effective for the removal of suspended solids.
	Filtration	Removes suspended and colloidal particles that are not easy to settle, using media filters, bags, or cartridges.	Yes	Effective for suspended solids removal following clarification.
	Carbon Adsorption	Activated carbon is used to adsorb volatiles, semi-volatiles, and pesticides.	Yes	Reliable and effective means for the removal of residual PAHs in groundwater, as well as low-level volatile organics and pesticides.

TABLE 2-7 (Sheet 5 of 6)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
INITIAL SCREENING OF GROUNDWATER REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	DESCRIPTION	TECHNICALLY FEASIBLE	CONCLUSION / COMMENTS
5. Treatment (Cont'd)	UV-Oxidation	Organics are oxidized and destroyed using hydrogen peroxide (or ozone) and ultraviolet (UV) light.	Yes	Not effective for heavy metals destruction or removal, but effective for organics.
	Ion Exchange	Metallic ions are removed by electrostatic exchange via ion resins.	Yes	Effective for removing metals present in the groundwater.
	Reverse Osmosis	Utilizes high pressures to force water through a membrane for selective separation of compounds.	Yes	Membranes are prone to fouling and incur high cost, but are effective for producing a high-quality effluent. It produces a high volume of reject wastewater requiring treatment and/or disposal.
	Biological Treatment	Uses microbes to degrade organic compounds into inert products of carbon dioxide and water.	No	Biodegradation is not likely to be effective for low-level residual organics to achieve cleanup levels.

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TABLE 2-7 (Sheet 6 of 6)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
INITIAL SCREENING OF GROUNDWATER REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	DESCRIPTION	TECHNICALLY FEASIBLE	CONCLUSION / COMMENTS
6. Disposal Technologies	Disposal/Discharge			
	Discharge to Groundwater	Re-injects treated groundwater back into the aquifer from which it was extracted.	No	Re-injection may cause bio-fouling, clogging, dead spots, air locks, and iron-content plugging.
	Discharge to Surface Water	Treated groundwater is discharged into a nearby surface body of water.	Yes	Surface water (Delaware River) is located adjacent to the site
	Discharge to POTW	Contaminated groundwater is extracted and transported (via sewer) to an off-site treatment and disposal facility.	Yes	Local POTWs may accept groundwater if it is in compliance with all applicable permits and pretreatment regulations.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
EVALUATION OF GROUNDWATER PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST
1. No Action	No Action			
	• Site Reviews *	Low[1]	High[2]	Low
2. Limited Action	• Institutional Controls			
	• Monitoring *	Low	High	Low
	• Public Awareness Program *	Low	High	Low
	• Use Restrictions *	Low	High	Low
3. Containment	• Containment			
	- Sheet Piling *	High	Moderate[3]	Moderate to High
	- Slurry Walls	High	Moderate	Moderate to High
	- Hydraulic Containment*	Moderate	Moderate	High
4. Removal/Treatment Actions	• Removal			
	- Extraction Wells *	High	Moderate	High

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TABLE 2-8 (Sheet 2 of 3)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
EVALUATION OF GROUNDWATER PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST
4. Removal/Treatment Actions (Cont'd)	• Treatment			
	- Neutralization / pH Adjustment *	Moderate	High	Moderate
	- Chemical Precipitation *	High	High	Moderate
	- Clarification *	High	High	Moderate
	- Filtration *	Moderate	High	Moderate
	- Carbon Adsorption *	High	High	Moderate
	- UV-Oxidation	Low	Moderate to High	High
	- Ion Exchange	Moderate	Moderate	High
	- Reverse Osmosis	Low	Moderate	High

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TABLE 2-8 (Sheet 3 of 3)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
EVALUATION OF GROUNDWATER PROCESS OPTIONS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY CATEGORIES AND PROCESS OPTIONS	EFFECTIVENESS	IMPLEMENTABILITY	COST
5. Disposal Actions	• Disposal/Discharge			
	- Discharge to Surface Water *	High	High	Low
	- Discharge to POTW	High	Low to Moderate	Low to High (depending on POTW fees)

* Designates representative process options selected for development of alternatives in Sections 3 and 4

(1) Low Effectiveness - not very effective
Low Implementability - difficult to implement
Low Cost - not very expensive

(2) High Effectiveness - very effective
High Implementability - easy to implement
High Cost - expensive

(3) Moderate Effectiveness - somewhat effective
Moderate Implementability - can be implemented
Moderate Cost - reasonable cost
Moderate ratings are also used to indicate uncertainty with respect to the evaluation of the criteria

Note that these ratings represent a broad range and that the process options are rated relative to each other within each technology type.

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Monitoring

Description: Long-term monitoring includes sampling and analyses of contaminated groundwater for assessing contaminant migration, detecting any changes in the environment, identifying any toxic or mobile transformation products, verifying that the plume is not expanding, verifying no negative impacts on downgradient receptors, and verifying attainment of remediation objectives.

Initial Screening: Long-term groundwater monitoring is a common support activity for achieving the groundwater-specific RAOs and implementing institutional controls. Therefore, it was retained for further evaluation.

Use Restrictions

Description: With this technology, restrictions would be specified as a CEA for the use under NJDEP regulations. In addition, well permit requirements may be established to restrict or regulate the installation of new wells and the continuing use of existing wells. This type of institutional control would be initiated by the local government and/or the state. Well permit requirements might require that future residents have their wells monitored on a regular basis to determine whether the contaminants have migrated to their wells.

Initial Screening: A CEA identification and well permits would be required as a final step in numerous process options. Thus, use restrictions were retained for further consideration as a process option.

2.4.3.3 Containment

Containment is a remedial technology capable of providing isolation of contaminated groundwater from uncontaminated groundwater, the Delaware River, and Crafts Creek. Containment technologies include vertical barriers such as sheet piling and slurry walls in order to form a barrier to contaminant migration. It is generally necessary to provide groundwater interception behind the barrier to prevent mounding and the potential spread of impacted groundwater around the barrier.

Sheet Piling

Description: Sheet piling driven into the soil can be used as a barrier to limit the spread of contaminants via groundwater movement. Steel or heavy gauge PVC sheet piling cutoffs require very little maintenance. Sheet piling should not be considered for use in very rocky soils. Recent advances in jointing technology have made sheet piling relatively resistance to leakage. If a complete barrier to groundwater flow is intended, groundwater must also be removed upgradient of the sheet piling to prevent mounding and flow around the barrier.

Initial Screening: Sheet piling can be used in any hydraulic condition (such as low or high groundwater movements). Sheet piling is most effective when it can be keyed into a low permeability bottom layer. Based on the four geological cross-sections of the site, a lower clay layer is evident on-site approximately 75 feet bgs. A "hanging wall" not keyed into the clay layer, in conjunction with groundwater extraction, may also effectively contain groundwater contamination.

Sheet piling would also achieve RAOs for groundwater including minimizing contaminated groundwater migration off-site Thus, this process option was retained.

Slurry Walls

Description: Slurry walls are the most common subsurface barriers because they are a relatively inexpensive means of reducing groundwater flow in unconsolidated earth materials. Slurry walls are constructed in a vertical trench that is excavated under a slurry. This slurry, usually a mixture of bentonite and water, acts essentially like a drilling fluid. It hydraulically shores the trench to prevent collapse, and at the same time, forms a filter cake on the trench walls to prevent high fluid losses into the surrounding ground. In some cases soil or cement are added to the bentonite slurry to form a soil-bentonite or cement-bentonite slurry wall. An upgradient groundwater extraction/removal arrangement would be incorporated into the construction of the wall to enable removal of collected groundwater, as necessary.

Initial Screening: Slurry walls are typically used when they can be "keyed" into a confining clay or bedrock layer and the groundwater does not move rapidly. A "hanging wall" not keyed into the clay layer, in conjunction with groundwater extraction, may also effectively contain groundwater contamination. Based on the four geological cross-sections of the site, a lower clay layer is evident on-site between 75 feet bgs. This is within the reach of modern excavating equipment. Much like other containment process options, utilizing slurry walls achieves the RAOs for groundwater, since it mitigates contaminated groundwater migration off-site. Therefore, this process option was retained.

Hydraulic Containment

Description: In order to prevent contaminated groundwater from leaving the site, hydraulic control via the removal of groundwater may be utilized. This technique involves the use of a line of extraction wells to pump out site groundwater as it flows toward the site boundary, thus preventing flow off-site. This water would need to be treated and discharged.

Initial Screening: Hydraulic containment relies upon the creation of overlapping capture zones by the pumping of extraction wells to prevent flow past the wells. In aquifers with good yield capacity, this results in excessive amounts of groundwater generated for subsequent treatment and disposal. At the site, hydraulic connections of the groundwater with the Delaware River at the site boundary will result in pumping river water along with contaminated site groundwater. This could be minimized by using a "hanging wall" to isolate groundwater from the river; therefore, this process option was retained.

2.4.3.4 Removal

Groundwater removal technologies involve restoration via contaminated groundwater extraction combined with treatment and disposal. The design of a groundwater extraction system depends upon the depth of contamination and hydrogeologic factors of the aquifer.

Extraction Wells (for Pump-and-Treat)

Description: Groundwater extraction wells screened within the aquifer utilize a submersible pump set within the screened interval to withdraw contaminated groundwater. Extraction wells are effective when the aquifer characteristics are favorable for a constant recharge of groundwater into the well. They are an efficient way of delivering groundwater to a treatment system and can be utilized for aquifer remediation.

Initial Screening: Pumping groundwater in a series of extraction wells would be feasible at the site because of the ability of the aquifer to support recharge to the wells. It was therefore retained for further evaluation as part of a groundwater remedy.

2.4.3.5 Treatment

Treatment technologies are used to change the physical or chemical state of a contaminant or to destroy the contaminant completely to reduce the volume, toxicity, or mobility of the contaminant. The categories of technologies that are included are *in situ* treatment and *ex situ* treatment (including physical, chemical, and biological treatment).

***In situ* Treatment**

In situ Funnel and Gate

Description: Funnel and gate involves the use of a vertical barrier, such as a sheet pile or slurry wall, to funnel groundwater towards an open reactive window or gate. Once the groundwater is directed towards the reactive window, it is then passed through an *in situ* treatment process (e.g., adsorber, biological degradation, filters, iron filings). If necessary, the *in situ* treatment process is accessed via a manhole in order to maintain the system (e.g., filter replacement, carbon replacement).

Initial Screening: Funnel and gate is a relatively new technology for passive groundwater remediation. This technology combines elements of both containment and treatment, and it employs conventional construction technologies, such as sheet pile and trenching. Due to the high metals contamination in the groundwater, excessive maintenance will be required and higher costs will be incurred from the frequent replacement of the fouled adsorption media or resin. This treatment is not amenable to the groundwater contaminants on site and thus, this process option was not retained.

In situ Biodegradation

Description: Biological treatment involves the use of native microbes to degrade a variety of organic compounds. *In situ* biodegradation promotes and accelerates natural processes in the undisturbed subsurface via the addition of oxygen, nutrients and other appropriate reagents. The applicability of a bioremediation approach is determined by the biodegradability of the organic constituents, and environmental factors affecting microbial activity.

Initial Screening: *In situ* biodegradation is a viable technology for application to impacted groundwater and is effective for remediation of organic constituents. Since heavy metals are the controlling contaminant, *in situ* biodegradation was eliminated from further consideration.

In situ Chemical Oxidation

Description: This technology involves the use of a chemical reagent that is injected into the groundwater via use of constructed wells or driven wellpoints to break down the organic constituents into carbon dioxide and water. The amount of reagent needed, spacing of injection points, and the frequency of addition to achieve cleanup goals are dependent upon organic constituent concentrations and groundwater flow.

Initial Screening: This treatment technology can best be applied to groundwater impacted with organic constituents. This process option, however, is not applicable to destroying inorganic contaminants. Since heavy metals are the controlling contaminant, this process option was not effective and is thereby eliminated from further consideration.

Ex Situ Treatment

This class of remedial technologies would be applied to groundwater that has been removed from the aquifer. Treatment technologies are used to change the physical or chemical state of a constituent or destroy the constituent completely to reduce volume, toxicity or mobility of the constituents present in site groundwater prior to disposal. This category of technologies includes physical treatment, chemical treatment, and biological treatment.

Neutralization/pH Adjustment

Description: Neutralization is a process used to adjust the pH (acidity or alkalinity) of a groundwater stream to an acceptable level for discharge, usually from 6.0 to 9.0 pH units. The pH adjustment is also a partial neutralization process which makes the water either more acidic or more alkaline to enhance chemical and biochemical reactions, specifically removal of dissolved metals. Adjustment of pH is accomplished by addition of acid or caustic.

Initial Screening: Neutralization/pH adjustment is a conventional and widely demonstrated means of adjusting the pH of a water stream before, during and/or after chemical precipitation. Since this process option may be a necessary step to achieve allowable pH levels for groundwater discharge, neutralization/pH adjustment was retained as a process option.

Chemical Precipitation

Description: Chemical precipitation is a process in which a precipitating agent is added to the point where the lowest solubility of the compounds to be removed is reached. Metals can be precipitated out of solution as hydroxides, sulfides, carbonates, or other insoluble salts.

Initial Screening: Limitations to be considered during design include the fact that not all metals have a common pH at which they precipitate. Chemicals to enhance the flocculation and coagulation of precipitated solids are added to the water at this time. These chemicals may include polymer, lime, sodium sulfide or ferric chloride depending upon the optimization results obtained during jar testing groundwater. Chemical precipitation is used effectively in conventional water treatment to remove dissolved metals and may be required as pretreatment for processes such as air stripping and carbon adsorption to prevent fouling, and also to meet discharge permit limitations. Since groundwater at the site contains metals, chemical precipitation was retained as a process option.

Clarification

Description: The primary function of clarification is to remove settleable suspended solids to produce a clear waste stream. The clarifier is typically equipped with an inclined plate pack to facilitate the settling process on a continuous basis. Settled solids fall into a hopper at the bottom of the unit for removal via a pump as 1-3% solids sludge.

Initial Screening: Clarification, which is a sedimentation process, has been shown to be applicable for the removal of suspended solids from chemical precipitation processes. This technology can be applied following chemical precipitation and was therefore retained as a process option.

Filtration

Description: Filtration is used to remove suspended and colloidal particles that are not easily settleable. The most common methods of filtration are media filters, such as sand and anthracite, or removable bags or cartridges. Fluid flow through the filter medium may be accomplished by gravity or by exerting pressure.

Initial Screening: Filtration is typically used after gravity separation for additional removal of suspended solids prior to other treatment processes. Pretreatment by filtration is appropriate for membrane separation processes, air stripper, ion exchange and carbon adsorption in order to prevent plugging or overloading of these processes. Filtration is often required to remove suspended solids remaining after clarification in order to meet discharge requirements. Therefore, it was retained as a process option.

Carbon Adsorption

Description: Activated carbon selectively adsorbs constituents in hazardous wastes by a surface attraction phenomenon in which the organic molecules and some metals are attracted to the internal pores of the carbon granules. Activated carbon can be used for the adsorption of volatile organics, semi-volatile organics, pesticides, and herbicides in groundwater. Adsorption efficiency is chemical specific, depending upon the strength of the molecular attraction between adsorbent and adsorbate, molecular weight, electrokinetic charge, pH, and surface area. Once the micropore surfaces are saturated with organics, the carbon is "spent" and must be replaced with fresh carbon or regenerated.

Initial Screening: Granular activated carbon adsorption is a highly developed organic removal technology. Pretreatment, such as precipitation and/or filtration, may be required to remove metals and/or suspended solids, so as to prevent fouling of carbon adsorber units. Activated carbon adsorption is an effective and reliable means of removing organic constituents to meet discharge criteria. This process option was therefore retained for further evaluation.

UV-Oxidation

Description: UV-oxidation is a process which can destroy many organic contaminants in water. The chemical oxidants used are either hydrogen peroxide or ozone. Organic contaminants absorb UV light and may undergo changes in their chemical structures or may become more reactive with chemical oxidants. When catalyzed by ultraviolet light, the oxidant (hydrogen peroxide or ozone) forms hydroxyl radicals. The hydroxyl radicals are strong chemical oxidants which react with the organic contaminants. If the reaction is carried to completion, organic compounds can be completely oxidized (broken down) to water and carbon dioxide.

Initial Screening: The UV-chemical oxidation process has been extensively studied over the past several years for its applicability for the broad spectrum of concentrated aqueous waste, industrial effluents and groundwater containing various organic contaminants. Also, extensive bench and pilot-scale testing may be required to determine the correct dosage of the oxidant (e.g., hydrogen peroxide, ozone). Although this process option is not effective for metals removal, it is effective for meeting organic discharge criteria for POTWs. Thus, this process option was retained.

Ion Exchange

Description: Selected contaminant ions are removed from the aqueous phase by electrostatic exchange with relatively innocuous ions held by ion exchange resins. Ion exchange is commonly used for removal of metallic cations or anions and other inorganic anions, it is also effective for removal of cyanide. Fixed bed and counter current vessels are the most widely used ion exchange systems. When the resin has no further capacity to exchange ions, it must be regenerated, resulting in a wastewater stream requiring further treatment prior to disposal. Replacement cartridges of resin may also be utilized, with subsequent regeneration taking place at an approved facility.

Initial Screening: Ion exchange can effectively lower concentrations of inorganic constituents in the groundwater. However, regeneration of spent ion exchange resin would generate wastewater containing high metals concentrations and acid or caustic solutions. This wastewater would require further treatment prior to disposal. The ion exchange resin may become fouled with the organic constituents in the site groundwater if installed upstream of organic treatment units, resulting in inefficient operation. This process can be used as a polishing unit to remove metals present in the site groundwater once the organics and suspended solids are removed. This process option was retained.

Reverse Osmosis

Description: Reverse osmosis utilizes high pressures to force water through a membrane resulting in selective separation of compounds from the water. A highly concentrated briny wastewater stream of approximately 20 percent of influent flow is generated requiring further treatment or disposal.

Initial Screening: This type of unit operation produces water of extremely high purity. The membrane may be prone to fouling due to the levels of organic constituents in the groundwater. This process option is generally used as a final polishing step or for removal of specific constituents in a complex groundwater treatment system. Since the treated water from reverse osmosis is a high quality stream, it can be discharged directly to surface water or the POTW. Therefore, this process option was retained.

Biological Treatment

Description: Biological treatment is a biochemical process in which organic constituents are broken down to simpler substances by microorganisms. Organic molecules are oxidized to carbon dioxide, water and other end products using molecular oxygen as the terminal electron acceptor. Oxygen may also be incorporated into intermediate products of microbial catabolism through the action of oxidizing enzymes, making them more susceptible to further biodegradation. Site groundwater would be processed in a fluidized bed biological reactor. The availability of oxygen and nutrients, the microbial population, and the retention time in the system are controlled through mechanical aeration, recycle rates, and supplemental nutrient feed rates.

Initial Screening: Biodegradation has been demonstrated to be effective on impacted groundwater. Fluidized bed reactors are effective in removing both low and high molecular weight organic non-chlorinated constituents. Since heavy metals are the controlling contaminant at the site, this process option is not effective and was not retained for further evaluation.

2.4.3.6 Disposal Technologies

This category of remedial technologies refers to on-site disposal via groundwater re-injection or discharge to surface water, as well as off-site disposal via POTW discharge.

Discharge to Groundwater

Description: Reinjection of treated groundwater is frequently used to restore the groundwater table of the aquifer from which the groundwater is withdrawn. This is feasible where hydraulic conductivity and transmissivity are high. Reinjection systems are used to direct contaminants to the extraction systems and to accelerate groundwater restoration. Potential problems involved with the use of reinjection systems include biological fouling, clogging, dead spots, air locks and plugging by chemical precipitation (reinjection of aerated water into groundwater with high iron content).

Initial Screening: This option works most effectively in undisturbed aquifers of homogeneous sandy/gravel units, but is favorable due to recharging the groundwater. Due to the shallow water table and the proximity to the river, this process option was not retained for further evaluation.

Discharge to Surface Water

Description: Treated groundwater is discharged into a nearby surface body of water, in this case, the Delaware River.

Initial Screening: Water bodies located adjacent to the site are available for surface water discharge of treated groundwater. The requirements of the NJDEP discharge to surface water levels must be met. Also, surface water discharge is the least disruptive to site hydrogeology. This option is readily implementable and was therefore retained as a process option.

Discharge to POTW

Description: Contaminated groundwater extracted from the site is conveyed to an off-site treatment facility for treatment and disposal. POTW can be considered for evaluation as an off-site treatment option.

Initial Screening: Untreated or partially treated groundwater from the site would be discharged to the sanitary sewer for additional treatment and discharge by the POTW. Even though the local POTW may have capacity restrictions, fees for use, and permit and/or pretreatment requirements, this process option was retained for further evaluation.

SECTION 3.0

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3.0 DEVELOPMENT OF ALTERNATIVES

3.1 INTRODUCTION

In this section, the feasible technologies identified in Section 2.4 are formed into potential remedial alternatives for the contaminated soils, sediments, and groundwater at the RSC. The alternative descriptions are presented for each medium, separately. Section 3.2 presents a description of alternatives for soils; Section 3.3 presents a description of alternatives for sediments; Section 3.4 presents a description of alternatives for groundwater; and Section 3.5 presents a screening of all alternatives. The sludge lagoons are included with the contaminated soil areas because the remaining sludge, from a contamination standpoint, is not significantly different from surface soils at the site. The Slag Disposal Area is also included within the soil alternatives. For each feasible technology, representative process options have been selected (e.g., soil and asphalt caps for capping of soils, sandy loam cap for sediments, etc.) for the formulation of alternatives. During the remedial design phase for OU-5, alternate process options that passed the initial screening within the technology type may be substituted for those selected.

During the development of alternatives, all soils and slag material are considered as a source to groundwater because of the widespread nature and extent of inorganic contamination. Extensive soil sampling results show that delineation of areas that exceed soil standards could not be achievable due to the heterogenous distribution of contaminants throughout the entire RSC, thereby making partial capping and partial removal/excavation options unreliable. The alternatives in the FS are subject to change based on future data that may be collected and demonstrate differing conditions. Five-year reviews, as required by CERCLA, also serve to evaluate whether conditions differ sufficiently from those expected to merit re-evaluation of selected alternatives.

3.2 DESCRIPTION OF ALTERNATIVES FOR SOILS

This section presents descriptions of each of the remedial alternatives for OU-5 soils, including descriptions of the soil area and/or volume to be remediated and major technological components. The following alternatives were developed by combining selected process options from Section 3.0. Although other technically feasible process options may be substituted during the design phase, these process options were chosen to represent a range of alternatives. As discussed previously, the Slag Disposal Area and the landfill area are included within the soil alternatives. Table 3-1 presents a summary of the quantities of material associated with each alternative. The following remedial alternatives have been developed for OU-5 contaminated soil and the Slag Disposal Area at the RSC:

Alternative SL1: No Action
Alternative SL2: Limited Action
Alternative SL3: Containment
Alternative SL4: Source Removal/Off-Site Disposal
Alternative SL5: Excavation /Soil Washing/On-Site Backfill
Alternative SL6: *In Situ* Stabilization/Containment

TABLE 3-1 (Sheet 1 of 3)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
REMEDIAL ALTERNATIVE QUANTITY SUMMARIES FOR SOIL[1]

ALTERNATIVE DESCRIPTION	LENGTH (FT)	AREA (YD^2)	VOLUME[2] (CY)
Alternative SL1: No Action	-	-	-
Alternative SL2: Limited Action			
1. Linear feet of fencing required to surround the perimeter of the site (Assumes 5% of existing fence requires replacement)	330	-	-
Alternative SL3: Containment			
Option (a)			
1. Contaminated soil area to be soil covered	-	414,000	-
2. Contaminated soil area to be asphalt covered	-	178,000	-
3. Contaminated slag area to be soil covered	-	165,000	-
4. Volume of clean fill soil required for main plant	-	-	207,000
5. Volume of top soil required for main plant	-	-	69,000
6. Volume of clean fill soil required for slag disposal area	-	-	83,000
7. Volume of top soil required for slag disposal area	-	-	28,000
Option (b)			
1. Contaminated soil area to be soil covered	-	592,000	-
2. Contaminated slag area to be soil covered	-	165,000	-
3. Volume of clean fill soil required for main plant (1.5 ft. depth)	-	-	296,000
4. Volume of top soil required for main plant (0.5 ft. depth)	-	-	99,000
5. Volume of clean fill soil required for slag disposal area (1.5 ft. depth)	-	-	83,000
6. Volume of top soil required for slag disposal area (0.5 ft. depth)	-	-	28,000

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
REMEDIAL ALTERNATIVE QUANTITY SUMMARIES FOR SOIL[1]

ALTERNATIVE DESCRIPTION	LENGTH (FT)	AREA (YD^2)	VOLUME[2] (CY)
Alternative SL4: Source Removal/Off-Site Disposal			
1. Soil to be excavated	-	592,000	861,000
2. Slag to be excavated	-	165,000	710,000
3. Volume of clean fill soil required for main plant	-	-	762,000
4. Volume of topsoil required for main plant	-	-	99,000
5. Volume of clean fill soil required for slag disposal area	-	-	683,000
6. Volume of topsoil required for slag disposal area	-	-	27,500
7. Volume of soil for off-site disposal	-	-	861,000
8. Volume of slag for off-site disposal	-	-	710,000
Alternative SL5: Excavation/Soil Washing/On-Site Backfill			
1. Soil to be excavated	-	592,000	861,000
2. Slag to be excavated	-	165,000	710,000
3. Soil volume to be backfilled	-	-	861,000
4. Slag volume to be backfilled	-	-	710,000
5. Volume of top soil required for main plant	-	-	99,000
6. Volume of top soil required for slag disposal area	-	-	28,000

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TABLE 3-1 (Sheet 3 of 3)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
REMEDIAL ALTERNATIVE QUANTITY SUMMARIES FOR SOIL[1]

ALTERNATIVE DESCRIPTION	LENGTH (FT)	AREA (YD^2)	VOLUME[2] (CY)
Alternative SL6: *In Situ* Stabilization/Containment			
1. Soil to be stabilized	-	592,000	861,000
2. Slag to be stabilized	-	165,000	710,000
Option (a)			
1. Soil area to be capped with soil cover	-	414,000	-
2. Soil area to be capped with asphalt paving	-	178,000	-
3. Slag area to be capped with soil cover	-	165,000	-
4. Volume of clean fill soil required for slag disposal area	-	-	207,000
5. Volume of topsoil required for slag disposal area	-	-	69,000
Option (b)			
1. Soil area to be capped with soil cover		592,000	
2. Slag area to be capped with soil cover		165,000	
3. Volume of clean fill soil required for main plant (1.5 ft. depth)		-	296,000
4. Volume of topsoil required for main plant (0.5 ft. depth)		-	99,000
5. Volume of clean fill soil required for slag disposal area (1.5 ft. depth)		-	83,000
6. Volume of topsoil required for slag disposal area (0.5 ft. depth)		-	28,000

NOTES:
(1) Calculations supporting quantity summaries are included in Appendix A of this document.
(2) In-place volume (either prior to disturbance or compacted placed fill).
- Not applicable.

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Descriptions of these alternatives are presented below.

3.2.1 Alternative SL1: No Action

The No Action alternative consists of no remedial activities that address the existing contaminated soil at the site; all contaminated soil would remain. However, this alternative would include five-year reviews of site data as required by CERCLA for sites where contamination remains after implementation of the selected remedy.

3.2.2 Alternative SL2: Limited Action

The Limited Action alternative for the soil at the RSC would include the installation of site security measures (i.e., repair fencing and maintain security guards), long-term monitoring (e.g., periodic inspection), and restrictions on land use in the form of a NJDEP DER. For the purpose of erosion control and stormwater management, this alternative would also include dust suppression, site re-grading, and seeding or vegetation.

Perimeter fencing already exists around the site boundary to restrict general public access to the site. Approximately 330 feet of new fencing would be installed under this alternative assuming that five percent of the existing fencing would require replacement. This fencing would be inspected no less often than annually with repairs made as needed.

Subcontracted security services (consisting of a round-the-clock guard team) are currently in place for the site as a whole; the site is patrolled periodically throughout each day. These services would be continued.

Because this alternative does not include contaminant removal, long-term monitoring would be performed and the site would have to be reviewed every five years per requirements of CERCLA. These five-year reviews would include the reassessment of human health and environmental risks due to the contaminated soil left on site.

3.2.3 Alternative SL3: Containment

This alternative includes containment of contaminated soil, including the Slag Disposal Area, by capping. Two distinct capping options (i.e., soil/asphalt and soil only) are considered in this alternative based on the physical characteristics of different portions of the site and current and likely future uses of each portion. In Option (a), which would be appropriate for a scenario in which some of the buildings on the site would remain, asphalt capping is used in conjunction with soil capping. For areas in the central portion of the site, where buildings may remain, asphalt capping is selected to minimize grade changes and to maintain access to the buildings. Areas on the perimeter of the site, where grade changes would be less disruptive to site operations, would be capped using approximately two feet of soil. Figure 3-1(a) shows the approximate areas for each type of cap in Option (a) based on the status of the buildings as of June 2001. In Option (b), all contaminated areas of the site would be capped with soil, as shown in Figure 3-1(b). This option would be selected in the event that all buildings on the site are demolished. These two options are presented to demonstrate the range of possibilities, recognizing that the final design may fall somewhere in between these, based on the redevelopment plans for the site, advanced building deterioration, worker health and safety issues, and feasibility of decontamination.

The implementation of this alternative for soil areas begins with clearing and grubbing vegetated areas of the site in preparation for placement of the cap. Other objects that do not exceed the thickness of the designated cap type in the area (i.e., two feet for soil, approximately one foot for asphalt) remain in place.

After preparation of each area, the specified cap type and thickness would be installed in each area. Soil cap areas would consist of approximately 1.5 feet of clean fill and six inches of topsoil to support vegetation. For Option (a), the total area to be capped with soil cover is 414,000 square yards. The asphalt cap areas would cover approximately 178,000 square yards and would consist of approximately six inches of gravel subbase and four to six inches of asphalt. For Option (b), the total area to be capped with soil cover is 592,000 square yards. The total Slag Disposal Area to be soil covered is 165,000 square yards, for both Option (a) and Option (b). A permeable liner would be placed beneath the cap to act as a visible marker (i.e., a warning layer) to minimize direct contact, should the overlying cap be breached.

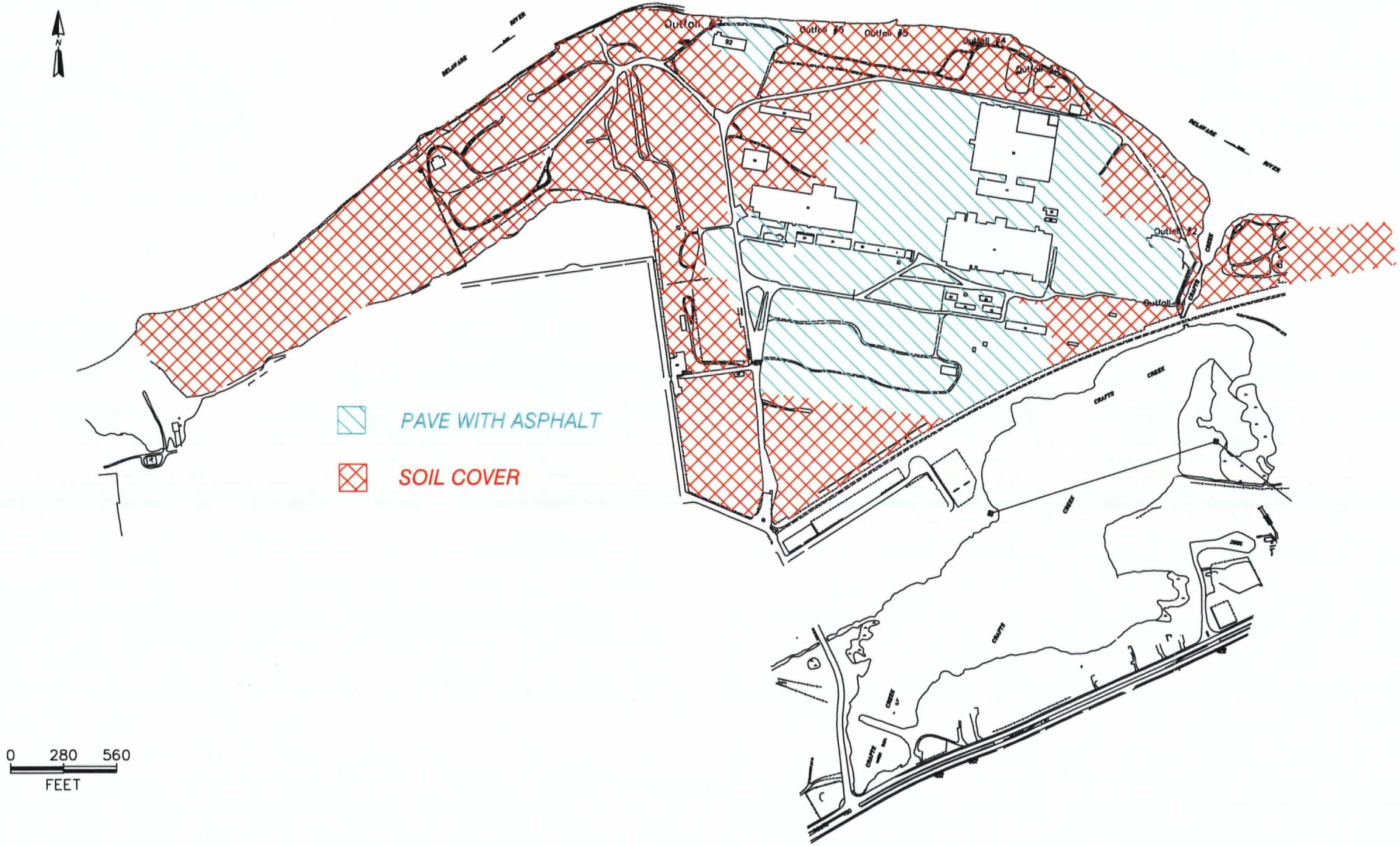
The total volume of clean fill and topsoil for the main plant areas are 296,000 cy and 99,000 cy, respectively. The total volume of clean fill and top soil for the Slag Disposal Area are 83,000 cy and 28,000 cy, respectively. These volumes are identical for both Option (a) and Option (b). Compaction, intermediate and final grading would be performed as required by the cap designs. Soil cap areas would be vegetated to stabilize the soils (i.e., prevent erosion).

The areas to be capped with soil cover generally do not have steep slopes or banks, except for those in the Slag Disposal Area. Stormwater management and erosion controls would be part of the site restoration and dust suppression, regrading, seeding/vegetation and bank stabilization, if necessary. In addition, catch basins, sewer lines, and outfalls would be provided in the asphalt cap areas for Option (a).

This alternative would require long-term maintenance of the capped areas to ensure that the caps do not erode or otherwise deteriorate, thereby exposing contaminated soil. A DER would be required to reduce the probability that future site activities would disturb the contained contaminants. Also, five-year reviews of site data would be required for compliance with CERCLA since contamination would remain on-site following implementation of this alternative.

3.2.4 Alternative SL4: Source Removal/Off-Site Disposal

This alternative consists of the excavation of all contaminated soil above cleanup levels, off-site disposal and site restoration. Excavation areas are shown on Figure 3-2. It is estimated that the total volume of soil to be excavated in the main plant area is 861,000 cy based on RDCSCC exceedances. The total volume of slag to be excavated is approximately 710,000 cy (Jacobi, 1996). The volume estimates for the main plant area were based on excavation depths of 4 to 10 feet, whereas the volume estimate for the Slag Disposal Area was based on the entire volume (34 acres at a depth of 13 feet), due to limited analytical data.



U.S. ENVIRONMENTAL PROTECTION AGENCY

Roebling Steel Company Site

Figure 3-1(a)

Alternative SL3 Containment Areas (Option a) for Soil and Slag Disposal Area

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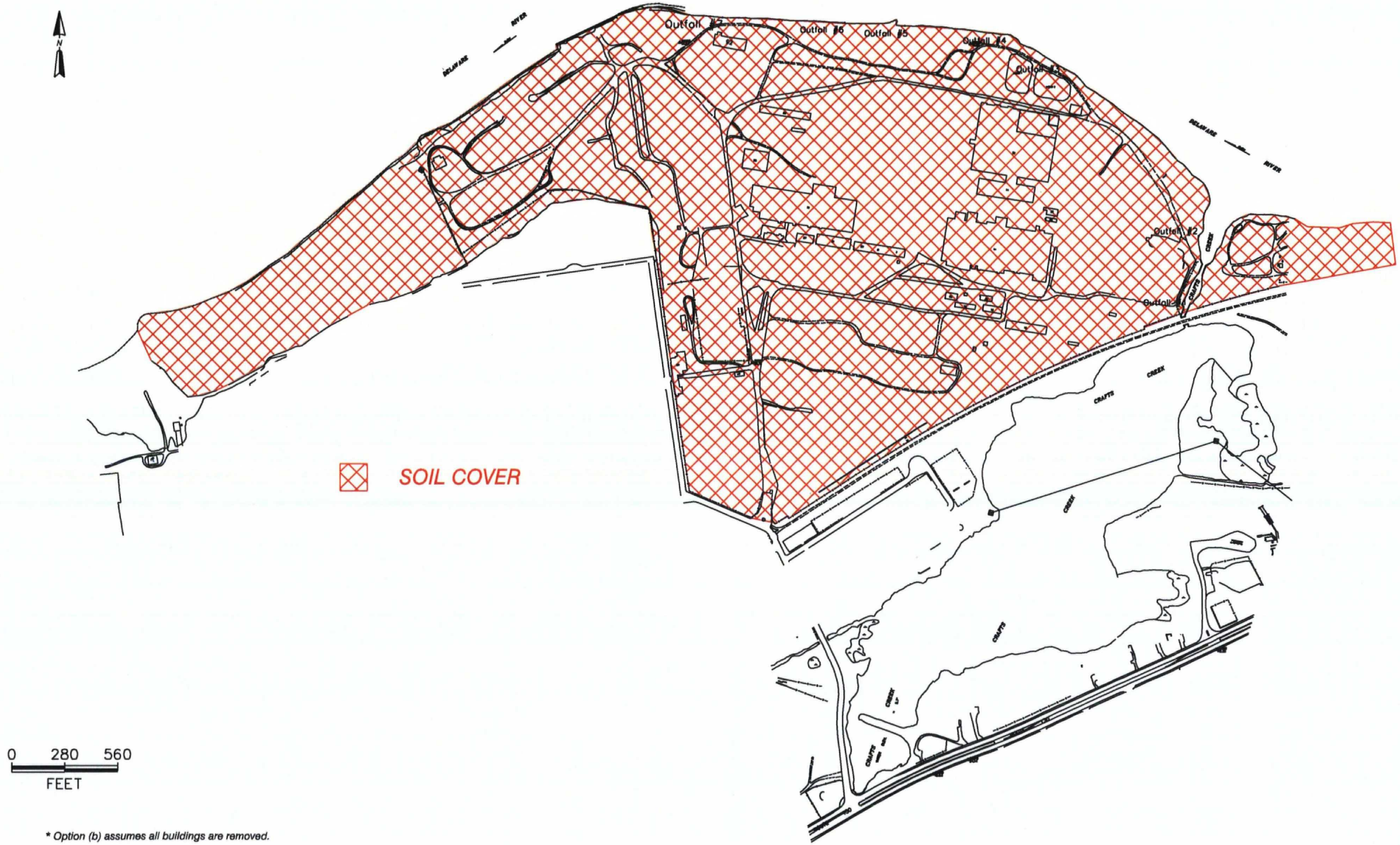

* Option (b) assumes all buildings are removed.

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Roebling Steel Company Site

Figure 3–1(b)

Alternative SL3 Containment Areas (Option b) for Soil and Slag Disposal Area

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New FS 3-1(b) 071602.dwg

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Figure 3–2

Alternatives SL4 and SL5 Source Removal Areas for Soil and Slag Disposal Area

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New FS Figure 3-2 070802.dwg

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Site preparation for implementation of this alternative would include clearing and grubbing (minimum necessary to facilitate excavation). Following site preparation activities, contaminated soils would be excavated using conventional excavation techniques. During remedial design, specific details regarding soil excavation would be addressed, such as the potential need for sheet piling, cofferdams, etc. to perform excavations along the shoreline. The approximate area of soil requiring excavation is 592,000 square yards. This area would be excavated to a depth of 4 to 10 feet, as presented in Appendix A. The excavated material would then be transported to an off-site permitted treatment, storage, and disposal (TSD) facility. OU-5 also includes the landfill area, located between the Slag Disposal Area and Building 88. Since this landfill received RCRA listed hazardous waste (e.g., baghouse dust), the excavated material from this area would need to be transported to a permitted facility that accepts RCRA listed hazardous wastes. Extra precautions may be taken to ensure that the RCRA listed waste does not come into contact with the other excavated soils in the vicinity of the landfill, otherwise they too would need to be managed as a RCRA listed hazardous waste. TCLP tests may also be performed on the landfill material to fully characterize the waste.

In addition, any materials that fail TCLP criteria need to be managed as hazardous waste, including transportation, disposal, and meeting LDRs. These materials cannot be disposed on site and must be transported to a permitted hazardous waste facility. Materials that do not fail the TCLP criteria would be managed as non-hazardous waste.

For this FS, it is assumed that 30 percent of excavated soils and 30 percent of excavated slag material (Jacobi, 1996) would be characteristic hazardous waste based on exceedance of TCLP limits for inorganics (i.e., Pb and/or Cr), and therefore would require treatment to comply with RCRA Land Disposal Restrictions.

Site restoration would consist of backfilling all excavations with clean fill to within six inches of original grade, placement of approximately six inches of top soil and revegetation to stabilize the soils. Restoration of soils would require approximately 762,000 cy of clean fill and approximately 99,000 cy of topsoil. Similarly, the volume of clean fill required for the Slag Disposal Area is 683,000 cy and the volume of topsoil is 28,000 cy. The areas to be backfilled are generally not steep slopes except for the Slag Disposal Area. Stormwater management and erosion controls would be part of site restoration and would include regrading, seeding/vegetation, and bank stabilization, if necessary.

3.2.5 Alternative SL5: Excavation/Soil Washing/On-Site Backfill

This alternative consists of excavation of contaminated soil, excavation of slag, on-site treatment by soil washing to meet the criteria for on-site backfill into the excavation areas, backfill and site restoration. Excavation areas are shown on Figure 3-2. It is estimated that the total volume of soil to be excavated for this alternative is 861,000 cy and the total volume of slag (in the Slag Disposal Area) to be excavated is 710,000 cy. Site preparation for implementation of this alternative would include clearing and grubbing (minimum necessary to facilitate excavation).

Following site preparation activities, contaminated soils would be excavated using conventional excavation techniques. During remedial design, specific details regarding soil excavation would be addressed, such as the potential need for sheet piling, cofferdams, etc. to perform excavations along the shoreline. All excavated soils would be treated to meet requirements for backfill. The evaluated treatment for development of this alternative is *ex situ* on-site soil washing.

The proposed treatment system includes feed preparation, soil washing, and soil leaching. The feed preparation unit would include equipment to remove debris (typically a bar screen), a size-reduction unit to break up large pieces (e.g., hammermill), and a pre-wash unit (e.g., log washer). The soil washer typically includes high-intensity scrubbing equipment (e.g., trommel), particle size separation, and density separation. The washed larger-size soil particles (typically greater than 100 mesh) should be sufficiently clean to be backfilled. These washed fractions would be stockpiled for analysis to confirm they meet criteria prior to backfilling. Following solids removal, water is recycled to the pre-wash unit. The fines from soil washing, which typically contain the highest concentrations, would be sent to the leach unit. This unit uses either an acid or chelating agent to dissolve the soluble lead and then recover the lead in a form suitable for recycle to a smelter. After lead removal, the spent leach solution is reconstituted and returned to the leach system (some leach solution may be used in the soil washer). At the conclusion of treatment, residual aqueous solution would then be treated to meet the requirements for discharge to surface water or transported off-site for treatment and disposal. The washed soil would be characterized to ensure it meets the criteria for on-site backfill and placed in the excavation areas. It is anticipated that treatment to below very stringent criteria (NJ residential soil cleanup levels) would be required in order to use excavated treated material as backfill. OU-5 also includes the landfill area, located between the Slag Disposal Area and Building 88.

Since this landfill received RCRA listed hazardous waste (e.g., baghouse dust), the excavated material from this area would need to be transported to a permitted facility that accepts RCRA listed hazardous wastes. Extra precautions may be taken to ensure that the RCRA listed waste does not come into contact with the other excavated soils in the vicinity of the landfill, otherwise they too would need to be managed as a RCRA listed hazardous waste. TCLP tests may also be performed on the landfill material to fully characterize the waste.

In addition, any materials that fail TCLP criteria need to be managed as hazardous waste, including transportation, disposal, and meeting LDRs. These materials cannot be disposed on site and must be transported to a permitted hazardous waste facility. Materials that do not fail the TCLP criteria would be managed as non-hazardous waste.

Stormwater management and erosion controls would be part of site restoration and would include dust suppression, regrading, seeding/vegetation and bank stabilization, if necessary. The areas to be excavated and backfilled are generally not steep slopes, except in the Slag Disposal Area.

3.2.6 Alternative SL6: *In Situ* Stabilization/Containment

This alternative employs stabilization of contaminated soil areas, with asphalt or soil capping over the stabilized material.

Implementation of this alternative begins with clearing and grubbing the site. Other objects that exceed the thickness of the cap (i.e., approximately one foot) would need to be removed and recycled or disposed off-site; smaller obstructions may be left in place and capped.

In situ stabilization converts impacted soils in-place into a stable cement type matrix by the addition of appropriate reagents such as Portland cement, fly ash silicate and/or proprietary agents. The contaminants are bound or trapped and become immobile. Large augers would be used to inject the stabilizing reagents and mix the impacted material. Field pilot testing would be needed to characterize the appropriate cementitious additives or stabilizing reagents (silicates), dosage rates, and other performance parameters that would be needed for final design. Assuming a 30 percent volume increase due to stabilization additives, the resulting volume of stabilized soil and slag would be approximately 1,119,000 cy and 923,000 cy, respectively. There are two options associated with Alternative SL6: Option (a) which includes both soil cover and asphalt capping and Option (b) which only includes the soil cover. These capping areas for the two options are identical to those in SL3, as presented in Figures 3-1(a) and 3-1(b). Stormwater management and erosion controls would be part of site restoration and would include dust suppression, regrading, seeding/vegetation and bank stabilization, if necessary. Five-year reviews would be required for this alternative, as contamination would remain after stabilization.

3.3 DESCRIPTION OF ALTERNATIVES FOR SEDIMENTS

This section presents descriptions of each of the remedial alternatives for sediments, including descriptions of the sediment area and/or volume to be remediated and major technological components. The following alternatives were developed by combining selected process options from Section 3.0. Although other technically feasible process options may be substituted during the design phase, these process options were chosen to represent a range of alternatives. Table 3-2 presents a summary of the quantities of material to be placed or removed from the site associated with each alternative. The following remedial alternatives have been developed for OU-5 for contaminated sediments at the RSC:

Alternative SD1: No Action
Alternative SD2: Limited Action
Alternative SD3: Containment
Alternative SD4: Dredging/Dewatering/Off-Site Disposal
Alternative SD5: Dredging/Dewatering/On-Site Disposal

Descriptions of these alternatives are presented below.

3.3.1 Alternative SD1: No Action

The No Action alternative would consist of no remedial activities that address the existing contaminated sediment at the site; all contaminated sediments would remain. However, this alternative would include five-year reviews of site data as required by CERCLA for sites where contamination remains after implementation of the selected remedy.

3.3.2 Alternative SD2: Limited Action

The Limited Action alternative for the sediments at the RSC would consist of a long-term sediment monitoring program, installation of site security measures (i.e., repair fencing and maintain security guards), and restrictions on land use in the form of a NJDEP DER. A long-term sediment monitoring program would be developed to ensure that risks resulting from on-site contamination do not increase.

TABLE 3-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
REMEDIAL ALTERNATIVE QUANTITY SUMMARIES FOR SEDIMENTS[(1)]

ALTERNATIVE DESCRIPTION	LENGTH (FT)	AREA (YD^2)	VOLUME[(2)] (CY)
Alternative SD1: No Action	-	-	-
Alternative SD2: Limited Action	-	-	-
Alternative SD3: Containment			
1. Contaminated sediment area to be covered with soil cap	-	87,000	-
2. Sediments to be dredged (1.5 ft. depth)	-	-	43,500
3. Volume of sediment/fill required (1.5 ft. depth)	-	-	43,500
Alternative SD4: Dredging/Dewatering/Off-Site Disposal			
1. Sediment area to be dredged	-	87,000	-
2. Volume of clean sediment/fill required (4 ft. depth)	-	-	116,000
3. Volume of sediment for off-site disposal	-	-	116,000
Alternative SD5: Dredging/Dewatering/On-Site Disposal			
1. Sediment area to be dredged	-	87,000	-
2. Volume of clean sediment/fill required (4 ft. depth)	-	-	116,000
3. Volume of sediment for on-site disposal (4 ft. depth)	-	-	116,000

NOTES:

(1) Calculations supporting quantity summaries presented here are included in Appendix A of this document.
(2) In-place volume (either prior to disturbance or compacted placed fill).
- Not applicable.

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Subcontracted security services (consisting of an around-the-clock guard team) are currently in place for the site as a whole; the site is patrolled periodically throughout each day. These services would be continued.

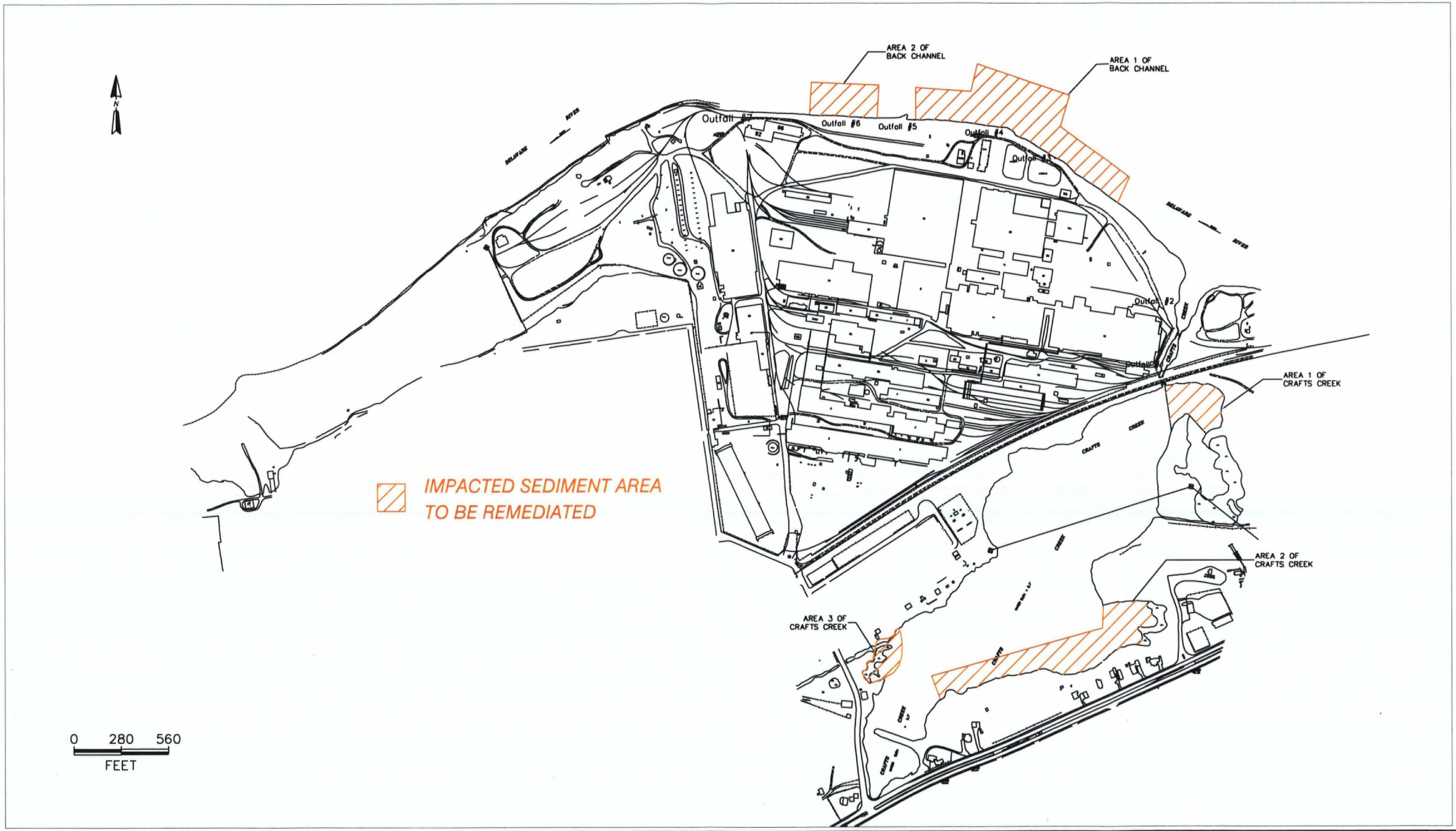
Because this alternative does not include contaminant removal, the site would have to be reviewed every five years per requirements of CERCLA. These five-year reviews would include the reassessment of human health and environmental risks due to the contaminated sediments left on site, using data obtained from the monitoring program.

3.3.3 Alternative SD3: Containment

This alternative includes containment of contaminated sediment by capping. Sediment areas would be capped with a compacted soil layer to establish a stable layer that effectively isolates contaminants from ecological receptors. Figure 3-3 shows the approximate sediment areas to be capped, which was estimated based on NOAEL values. During design, the areas to be capped would be refined to ensure that areas exceeding the NOAEL values are addressed. Alternative SD3 also includes long-term monitoring and long-term maintenance, since contaminants remain in the sediment. Wetland restoration would also be performed, if the initial restoration is not satisfactory.

Contaminated sediments near the site cover a total of approximately 87,000 square yards or 18 acres; approximately 12 acres are located in wetlands that need to be maintained or restored to their original value and function after remediation. Approximately nine acres of wetlands would be impacted within Crafts Creek and three acres of wetlands would be impacted within the Back Channel. Within Crafts Creek, three areas would be impacted. Area 1 encompasses 1.75 acres of emergent wetlands, Area 2 consists of 6.0 acres of emergent wetlands, and Area 3 contains 0.8 acre of emergent wetlands and 0.55 acres of forested wetland. Two areas would be encapsulated within the Back Channel. Area 1 of the Back Channel encompasses 3.0 acres of emergent wetlands and approximately 4.0 acres of state open waters, which meet the definition of waters of the United States. Area 2 encompasses 1.75 acres of state open waters, i.e., waters of the United States. In order to meet this requirement, these areas would need to be returned to approximately their current grade, and would need to be composed of materials capable of supporting vegetation similar to existing vegetation.

Therefore, to prepare these areas for placement of approximately six inches of compacted soil and 12 inches of a sandy loam soil (with 5-10 percent organic matter) or other material capable of supporting wetland vegetation, approximately 18 inches of existing sediments would be removed by dredging. This would allow placement of the cap without significantly changing existing elevations. Final elevations would be determined during design. Sediment removal in shallow water would be performed using conventional excavation technologies. Removal in deeper water would require conventional dredging methods. Appropriate measures would be implemented to control contaminant migration from sediments. In addition, excavation and/or dredging activities would be scheduled during low flow periods. Specific details for dredging/excavation and sediment erosion control would be provided during Remedial Design. The resulting excavated sediments with a total volume of approximately 43,500 cy would be disposed off-site or on-site. After preparation of each area, the cap would be installed. Compaction, intermediate and final grading would be performed as required by the cap design. Capped areas would be vegetated to restore the wetlands.



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Roebling Steel Company Site

Figure 3-3

Alternatives SD3, SD4, and SD5 Impacted Sediment Areas to Be Remediated

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This alternative would require long-term maintenance of the capped areas to ensure that the caps do not erode or otherwise deteriorate, thereby exposing contaminated sediments. This alternative includes a period of monitoring (e.g., 3 to 5 years) and additional wetland restoration if the initial restoration is not satisfactory. No long-term O&M would be associated with this alternative, since all of the contaminants are removed. A DER would be required to reduce the probability that future site activities would disturb the contained contaminants. Also, five-year reviews of site data would be required for compliance with CERCLA since contamination would remain on-site following implementation of this alternative.

3.3.4 Alternative SD4: Dredging/Dewatering/Off-Site Disposal

This alternative consists of dredging the contaminated sediments, dewatering the dredged sediments, off-site disposal, and site restoration. Areas to be remediated by dredging are also shown on Figure 3-3. As indicated, in Alternative SD3, these areas would be refined during Remedial Design to address NOAEL exceedances. It is estimated that the total volume of sediments to be dredged is 116,000 cy. This alternative also includes a period of monitoring (e.g., 3 to 5 years) and additional wetland restoration if the initial restoration is not satisfactory. No long-term O&M would be associated with this alternative, since all of the contaminants are removed.

Contaminated sediments would be dredged using conventional techniques. The area of sediments requiring excavation is approximately 87,000 square yards or 18 acres as described in Alternative SD3. The acreage of wetlands that would be disturbed was discussed in Alternative SD3. For the development of the alternative during the FS, it has been assumed that the average depth of non-consolidated silty sediment material is four feet. The objective of the sediment remediation is to remove all of the loose silty material down to the hard stream/river bottom in the contaminated area to remove the potential of exposure to ecological receptors.

Dredged material (116,000 cy) would be managed based on characterization after dredging. Results from the RI indicate that sediments to be dredged contain concentrations of constituents exceeding ecological benchmarks and posing risks to ecological receptors; however, based on these results, it is assumed that these materials would not be characterized as RCRA Hazardous Waste. The sediments would be removed because they are above a specified cleanup level and pose an unacceptable risk to human health and the environment. However, they may not be defined as a hazardous waste for disposal purposes, and it may be possible to dispose of them (e.g., in a landfill) without treatment. Excavation and/or dredging activities would be performed as discussed in Alternative SD3. To improve material handling, the dredged materials would be dewatered prior to being transported off-site for disposal at a non-hazardous landfill or other approved dredge spoil disposal location. Water recovered from the dewatering operation would be treated and appropriately discharged in accordance with all applicable requirements.

Under this alternative, sediment dredge areas within the upper 12 to 18 inches of substrate would be restored by placement of a sandy loam soil with 5 to10 percent organic matter or other suitable substrate. The balance of the backfill would consist of clean sand to return them to existing grade, and revegetation to establish wetlands of function and value at least equal to the existing wetlands. Restoration of sediments would require approximately 116,000 cy of high sand content fill. While this FS assumes that all sediment areas would be restored, it may not be necessary to place new material in the Back Channel area, which currently contains approximately 3 acres of emergent wetland, since it is expected that natural deposition would replace sediments in this area over time. This possibility would be evaluated during design.

3.3.5 Alternative SD5: Dredging/Dewatering/On-Site Disposal

This alternative is very similar to Alternative SD4 with dredging of all contaminated sediment, dewatering and disposal. The major difference between the alternatives is that disposal of the sediments would be on-site. This alternative also includes a period of long-term monitoring (e.g., 3 to 5 years) and additional wetland restoration if the initial restoration is not satisfactory. No long-term O&M would be associated with this alternative, since all of the contaminants are removed.

Dredging and dewatering activities are as described in Alternative SD4. Although the contaminated sediments pose a risk to ecological systems and the environment, it is assumed that the excavated sediments would be non-hazardous and; therefore, not require treatment prior to disposal; an estimated volume of 116,000 cy of sediments would be placed on-site.

Site restoration would be as described under Alternative SD4. In addition, the sediments would be placed on-site. Cleanup requirements for sediments, to mitigate risks to the environment, are much more stringent than cleanup for soil. It may be possible to remove the contaminated sediment to meet cleanup criteria and place it on-site, since the contaminant levels in the sediment may be below the soil cleanup criteria. Excavation and/or dredging activities would be performed as discussed in Alternative SD3.

3.4 DESCRIPTION OF ALTERNATIVES FOR GROUNDWATER

This section presents descriptions of each of the groundwater remedial alternatives, including descriptions of the volume to be remediated and major technological components. The following alternatives were developed by combining selected process options from Section 3.0. Although other technically feasible process options may be substituted during the design phase, these process options were chosen to represent a range of alternatives. The following remedial alternatives have been developed for contaminated groundwater at the RSC:

Alternative GW1: No Action
Alternative GW2: Limited Action
Alternative GW3: Containment via Barrier Walls
Alternative GW4: Restoration (Extraction Wells for Pump-and-Treat)
- Option (a): with source removal
- Option (b): without source removal

Descriptions of these alternatives are presented below.

3.4.1 Alternative GW1: No Action

The No Action alternative would consist of no remedial activities that address the existing contaminated groundwater at the site; all contaminated groundwater would remain. However, this alternative would include five-year reviews of site data as required by CERCLA for sites where contamination remains after implementation of the selected remedy.

3.4.2 Alternative GW2: Limited Action

The Limited Action alternative for the groundwater at the RSC would consist of a long-term groundwater monitoring program, and restrictions on groundwater use in the form of a NJDEP DER and CEA. A monitoring program would be developed to ensure that risks resulting from on-site contamination do not increase. The long-term monitoring program would be performed in accordance with a Long-Term Monitoring Plan, which would be developed in accordance with the Final OSWER Monitored Natural Attenuation Policy, following adequate delineation of the groundwater plume. The annual groundwater monitoring program would include 18 wells in total, 14 shallow wells, and 4 deep wells. Samples would be collected using low flow sampling techniques and analyzed for TAL inorganics, VOCs, and PAHs from select wells. Monitoring of sediment and surface water quality may also be incorporated into the long-term monitoring program if it is established during Pre-Design Investigations that groundwater is an ongoing source of contamination to sediment and/or surface water.

Because this alternative does not include contaminant removal, the site would have to be reviewed every five years per requirements of CERCLA. These five-year reviews would include the reassessment of human health and environmental risks due to the contaminated groundwater left on site, using data obtained from the monitoring program.

3.4.3 Alternative GW3: Containment via Barrier Walls

This alternative utilizes groundwater containment at the site via vertical subsurface barrier walls, to prevent off-site contaminant migration. The configuration incorporates groundwater pumping to prevent mounding and head build-up behind the walls. Where discontinuities occur (if any) in the low permeability layer, the barrier walls (steel sheet pile) would be installed to a depth that sufficiently contains the dissolved contaminants in the groundwater.

Hydrogeologic modeling utilized data from the site-wide geotechnical sampling and analysis programs to optimize the design of Alternative GW3 and generate the best depth profile of the barrier wall. The cutoff wall depth ranges from 63 to 73 feet both in Layer 1 and Layer 3. The groundwater flow to achieve hydraulic control is 70 gpm from seven extraction wells screened in both layers, as shown in Figure 3-4. The extracted groundwater would need to be restored via treatment and discharge, as described in Section 3.4.4.

Alternative GW3 would not result in the attainment of target cleanup levels upon completion of the remedial activities. Although this containment measure does not reduce contaminant toxicity, it would reduce the volume and inhibit the mobility of contaminated groundwater. However, the 1,950-foot barrier wall would only be located along the Delaware river where sediments were historically impacted. The vertical barrier would reduce the potential for off-site migration of contaminants and minimize the potential for impacts to sediment and surface water.

The long-term monitoring program would be performed in accordance with a Long-Term Monitoring Plan, which would be developed in accordance with the Final OSWER Monitored Natural Attenuation Policy, following adequate delineation of the groundwater plume. The groundwater monitoring program would include 18 wells in total, 14 shallow wells, and 4 deep wells. Samples would be collected using low flow sampling techniques and analyzed for TAL inorganics, VOCs, and PAHs from select wells. Surface water and sediment sampling may also be incorporated as discussed in Alternative GW2.

3.4.4 Alternative GW4: Restoration (Extraction Wells for Pump-and-Treat)

Alternative GW4 includes groundwater restoration via extraction wells and a pump-and-treat system. There are 15 wells that extract the groundwater from both Layer 1 and Layer 3, as shown in Figure 3-5. The system would include several process options for the removal and/or destruction of certain contaminants, as shown in Figure 3-6.

Contaminated site groundwater would be restored via the following extraction, treatment, and disposal unit operations:

1. Extracted groundwater is pumped from a main pipeline to an equalization tank.
2. Dissolved heavy metals are precipitated out of the water stream, in the form of metal hydroxides.
3. Suspended solids are separated from the groundwater.
4. Remaining unsettled solids are removed via a sand filter.
5. Low-level VOCs, PAHs, and pesticides are removed via liquid-phase carbon adsorption.
6. Groundwater is neutralized via pH adjustment to acceptable discharge limits.
7. Groundwater is discharged to surface water or POTW.

The groundwater extraction pumps would transfer approximately 93 gpm of contaminated groundwater to a main pipeline leading into the treatment building, where it would fill a 12,500 gallon equalization tank. The groundwater can then be pumped into the treatment system from the equalization tank at a constant flow rate via a centrifugal pump prior to the metals precipitation/clarification tank.

Liquid caustic (NaOH) is added in-line prior to the clarifier, thereby raising the pH and causing chemical precipitation of the metals present in the groundwater. It should be noted that caustic was recommended, instead of lime, since it is available in liquid or solid form, in-line addition is feasible, minimum retention time is required, and there is less sludge generation. This precipitation/clarification step is necessary since these materials have the ability to disrupt downstream unit operations by plugging lines and clogging equipment, clogging carbon, and raising effluent discharge concentrations.

A sand filter follows the caustic in-line addition and clarification steps. The effluent from the clarifier enters the filter via a centrifugal pump. Continuous sand filtration would polish the waste steam by removing residual metal hydroxides (precipitates) and total suspended solids (TSS), not removed by sedimentation following the precipitation step. The sand filter has a continuous backwash reject stream of 5-7 percent of the inlet flow that would be recycled back into the clarifier. A pump is used to introduce water into the base of the filter to aid filter upflow.

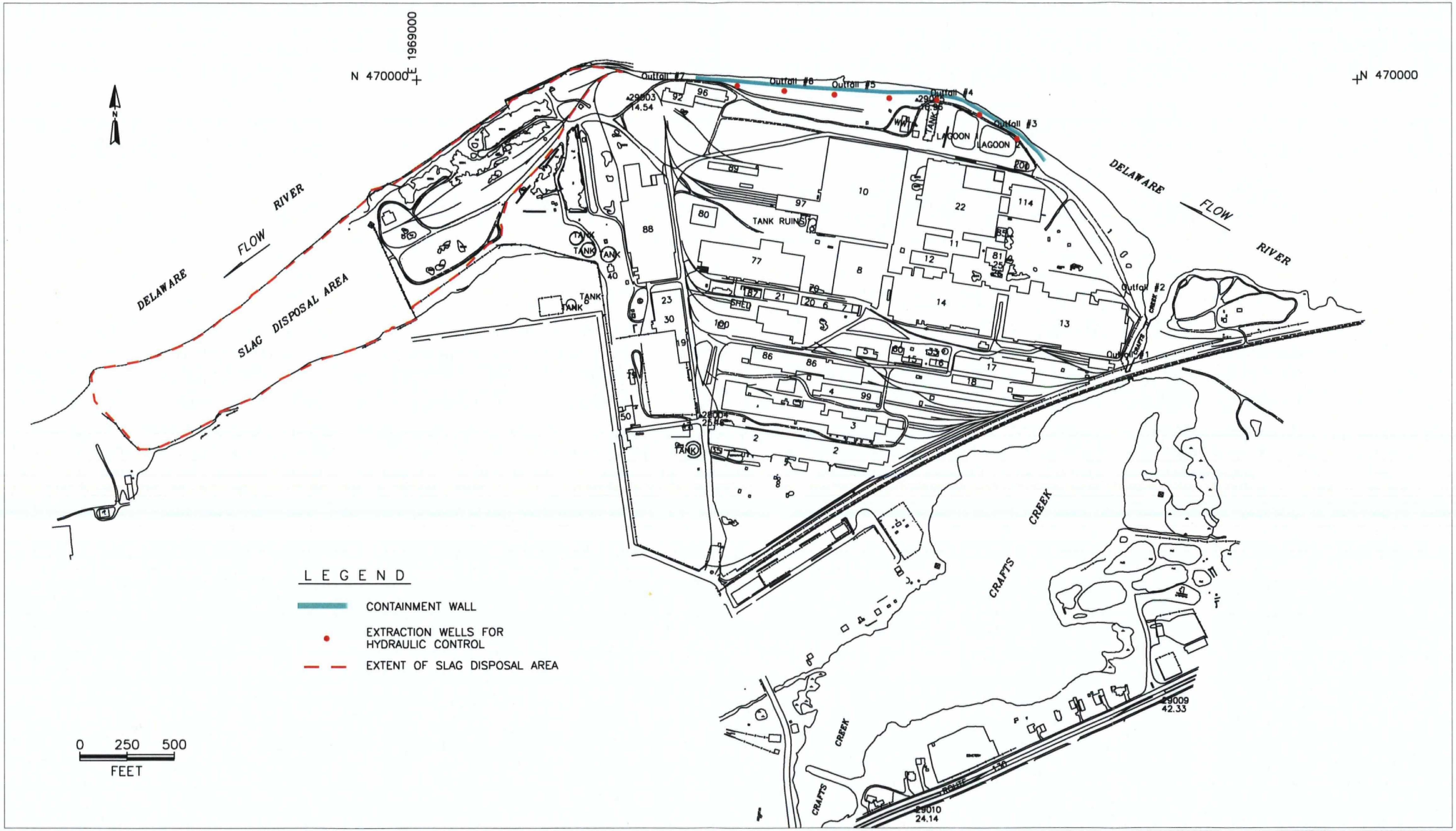

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Figure 3–4

Alternative GW3 Containment With Hydraulic Control

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New FS 3-4.dwg

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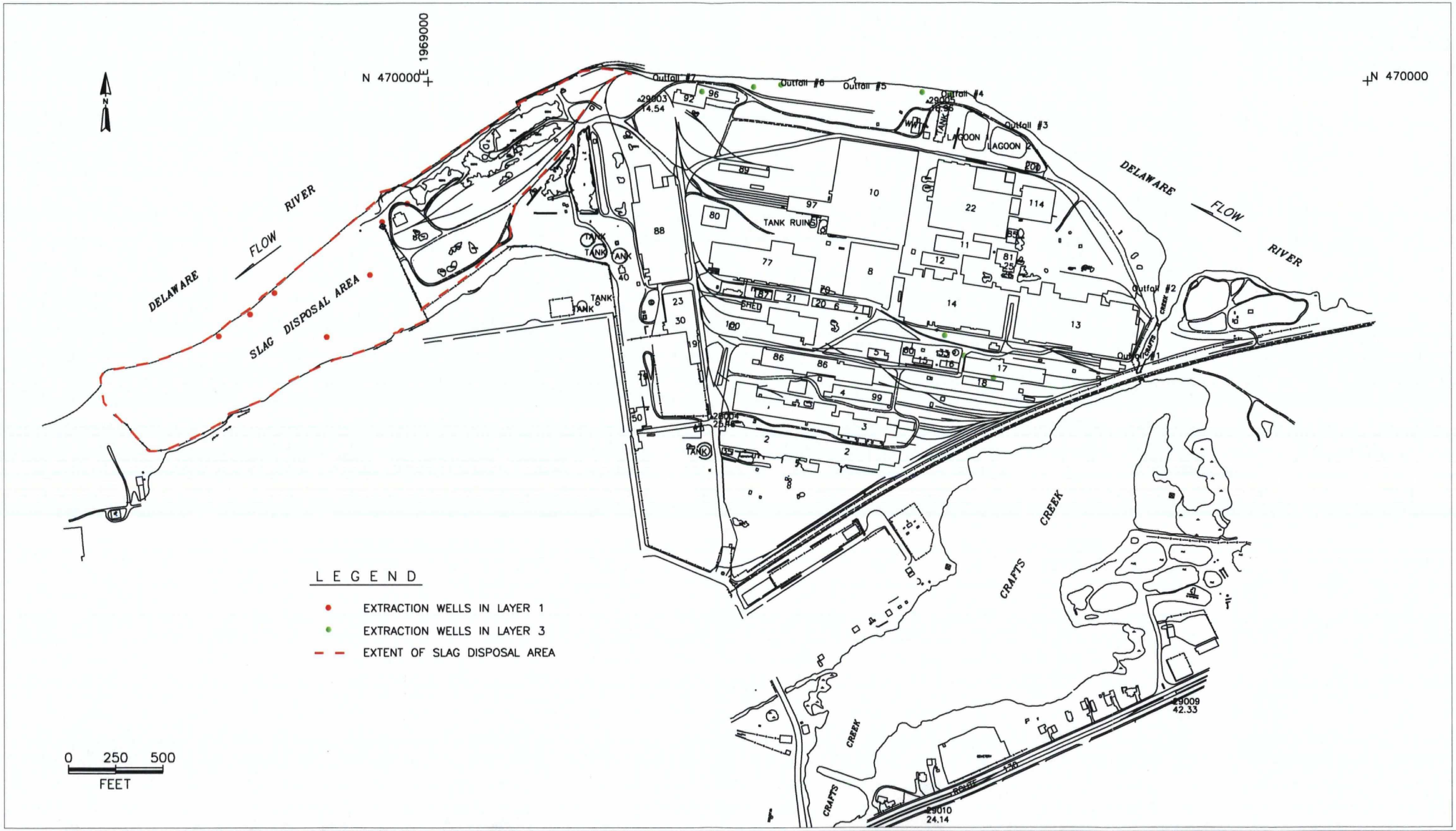

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Figure 3–5
Alternative GW4 Restoration Extraction Wells

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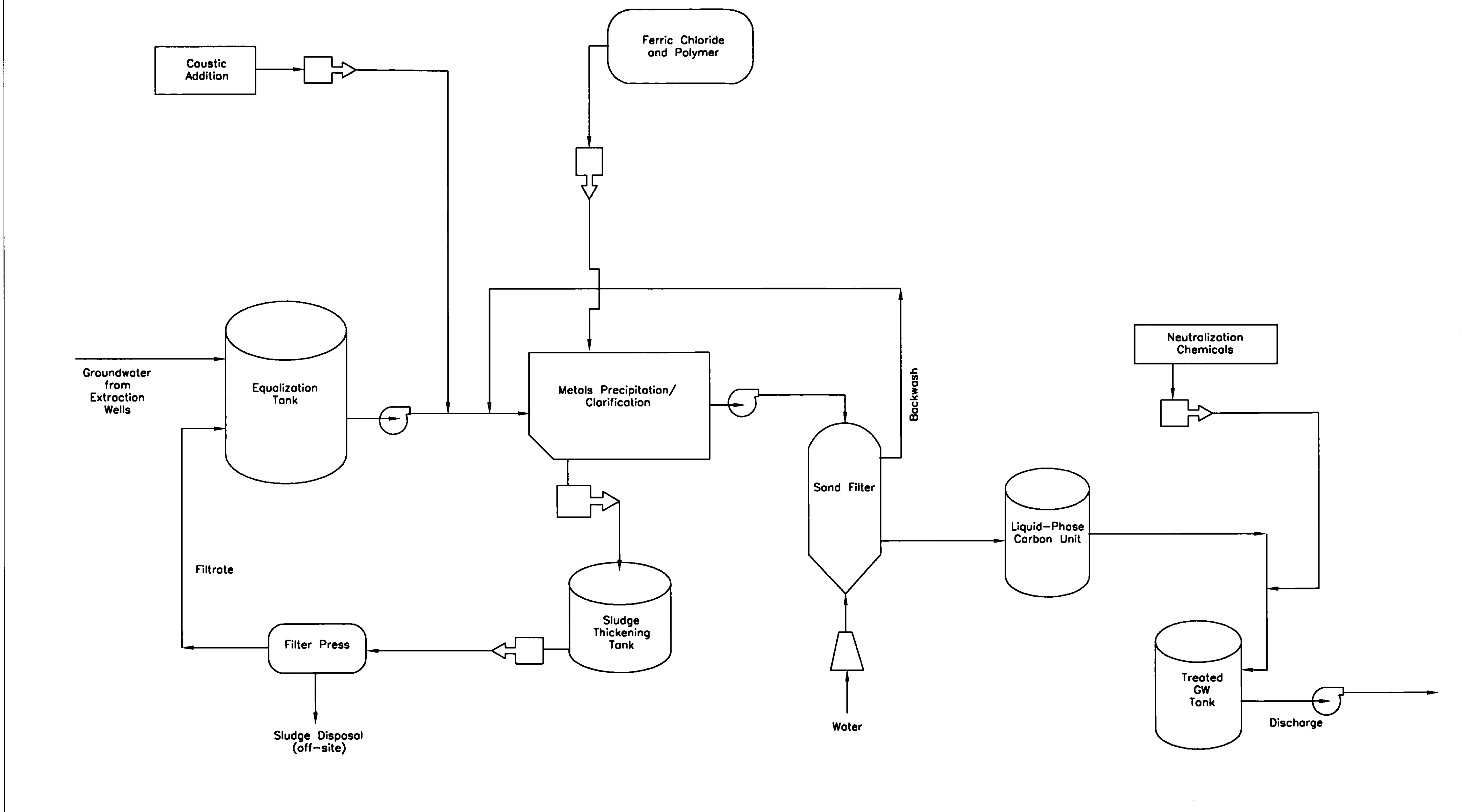

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Figure 3-6
Alternative GW4 Groundwater Treatment System

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New FS 3-6.dwg

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Following the filtration step is VOC, SVOC (including residual PAHs), and pesticide removal. Due to the low levels of these contaminants, it is viable to employ a large-scale liquid-phase carbon adsorption system. However, it should be noted that this type of treatment involves regenerating the activated carbon to maintain desired treatment levels.

The final polishing step of the treatment process is neutralization. It is often necessary to adjust pH to the acceptable discharge range of 6.0-9.0, which is accomplished by the addition of an acid or alkali. It is also necessary to ensure compatibility of the waste and treatment chemicals to prevent the formation of more toxic or more hazardous compounds than were originally present.

Treated groundwater would flow to a treated groundwater tank and then be discharged to the Delaware River, the surface water body adjacent to the site or to the local POTW.

There are two options associated with Alternative GW4: Option (a) which includes source removal and Option (b) which does not include source removal. Source removal consists of excavating all of the impacted soils from the main plant area (OU-5) and all of the material in the Slag Disposal Area (OU-3), as described in Section 3.2.4. The necessary site preparation for implementing the source removal in Option (a) is as discussed in Section 3.2.

The long-term monitoring program would be performed in accordance with a Long-Term Monitoring Plan, which would be developed in accordance with the Final OSWER Monitored Natural Attenuation Policy, following adequate delineation of the groundwater plume. The groundwater monitoring program would include 18 wells in total, 14 shallow wells, and 4 deep wells. Samples would be collected using low-flow sampling techniques and analyzed for TAL inorganics, VOCs, and PAHs from select wells. Surface water and sediment sampling may also be incorporated as discussed in Alternative GW2.

It should be noted that a TI waiver is being sought site-wide for the restoration of contaminated groundwater described in this alternative (GW4). The justification for this waiver is based on the TI Evaluation, which details the extremely long time to remediate the site, the large volume of groundwater to be remediated, the high cost of this alternative, and the difficulty in extracting the inorganics from the aquifer.. The TI Evaluation is presented in Appendix E.

3.5 SCREENING OF ALTERNATIVES

The alternatives developed in the previous sections represent a range of alternatives including no action, limited action and several different treatment/disposal options for addressing the risks at the site. In this section, the media-specific alternatives are evaluated against three broad screening criteria: 1) effectiveness; 2) implementability; and 3) cost. The purpose of this screening is to reduce the number of alternatives subject to detailed evaluation, carrying forward only the most promising alternative for detailed evaluation.

3.5.1 Screening of Soil Alternatives

3.5.1.1 Alternative SL1: No Action

Description: The No Action alternative includes five-year site reviews and is used as a baseline for which the other alternatives are compared.

Effectiveness: No Action is minimally effective since all of the contamination remains on-site and neither ARARs nor TBCs are satisfied. In addition, there is no protection of human health or the environment, there is no reduction in toxicity, mobility, or volume, and both the environment and wildlife would continue to be impacted from the existing conditions. However, there are no increased risks to the community or site workers.

Implementability: This alternative is highly implementable, since there is no major construction, treatment, equipment, materials, nor monitoring involved. Additional remedial action can be easily undertaken, if necessary; however, it may be necessary to go through the RI/FS/ROD process again. The five-year site reviews are easily implementable.

Cost: The cost is very low since there are no capital costs. The present worth cost of $54,000 is incurred from the five-year site reviews.

Conclusion: In accordance with CERCLA requirements, the No Action Alternative is retained for detailed evaluation as a baseline for comparison of other alternatives.

3.5.1.2 Alternative SL2: Limited Action

Description: The Limited Action alternative includes long-term soil monitoring, five-year reviews, and institutional controls, such as access restrictions and NJDEP DER. For the purpose of erosion control and stormwater management, this alternative would also include dust suppression, site re-grading, and seeding or vegetation.

Effectiveness: Limited Action is minimally effective since all of the contamination remains on-site, the unreliability of institutional controls, ARARs nor TBCs are satisfied, there is little protection of human health, there is no reduction in toxicity, mobility, or volume, and both the environment and wildlife would continue to be impacted from the existing conditions. However, there are no increased risks to the community or site workers.

Implementability: The land use restrictions could be easily implemented and continued security measures are easily accomplished. Considerable long-term institutional management would be associated with this alternative for maintenance of institutional controls, and the long-term soil monitoring and five-year reviews. NJDEP requirements for a DER would have to be met. The monitoring equipment and analytical laboratories are commercially available and proven. Services and materials required for security measures, site monitoring, and erosion control/stormwater management are readily available in the area. Numerous vendors would be available for competitive bids.

Cost: The present worth cost of this alternative is $5,869,000.

Conclusion: Since the institutional controls and access restrictions would mitigate human health risks associated with exposure to contaminated soil, this alternative is retained for detailed evaluation.

3.5.1.3 Alternative SL3: Containment

Description: This alternative combines soil capping and asphalt capping to contain contaminated soils, as well as soil capping for the Slag Disposal Area. Soil and asphalt caps would be used on different portions of the site as discussed for Option (a), or a soil cap would be used over the entire site as discussed for Option (b), to completely contain contaminants and eliminate the exposure routes of concern. Erosion control/stormwater management would also be included.

Effectiveness: Containment of contaminated soil provides overall protection of human health and the environment by eliminating the contaminant exposure pathways for human and ecological receptors. All activities for this alternative would be performed in accordance with location and action-specific ARARs or waivers would be sought, if necessary.

Capping of contaminated soil would eliminate exposure risks as long as the capped areas were maintained and future activities did not disrupt the capped areas. Since the contamination is left in place, the potential exists for migration of contaminants into groundwater and/or surface water and the establishment of new exposure routes. This alternative would not result in any reduction of toxicity, mobility or volume through treatment. Areas that are capped with impermeable materials (i.e., asphalt over soil) would likely exhibit a reduction in mobility of contaminants via infiltration and/or erosion, but only if these caps are maintained. Areas covered with clean soil may exhibit a lesser reduction.

Implementability: All the components of this alternative are well developed and commercially available, since capping is an easily implemented technology. Long-term monitoring and maintenance would also be required. Implementation of this alternative would require continued restrictions on site access during construction. Since contamination would remain on site, a DER or other type of deed restriction would be required; these restrictions could require the cooperation of and/or negotiations with future property owners. Construction services and materials for cap construction are readily available as these represent conventional construction activities.

Cost: The present worth cost of this alternative is $24,422,000 for Option (a) and $20,479,000 for Option (b).

Conclusion: Since this alternative meets the RAOs and can be readily implemented, Containment would be retained for detailed evaluation.

3.5.1.4 Alternative SL4: Source Removal/Off-Site Disposal

Description: This alternative includes source removal, off-site treatment, and off-site disposal. The source removal consists of all impacted soil and slag material which exceed the most stringent

ARARs/TBCs. The majority of the soil areas would be excavated to four feet bgs; the "hot spot" excavation depths are approximately eight to ten feet bgs, depending on the area. The areas and associated excavation depths are presented in Appendix A. Clean fill and topsoil would be used to restore excavated areas and all areas would be revegetated. Erosion control/stormwater management owld also be included.

Effectiveness: The excavation and removal of contaminated soil from the site would eliminate the potential human health and ecological risks associated with exposure to contaminated soils, and would result in overall protection of human health and the environment. In addition, this alternative would comply with ARARs/TBCs. The excavation and removal of contaminated soil and slag would reduce the potential human health risks associated with direct contact. All excavated areas would be replaced by clean materials. Since all of the contaminated materials are removed, there is a significant reduction of toxicity, mobility, and volume.

Implementability: All the components of this remedial alternative are well developed and commercially available. Due to site conditions in certain areas (e.g., slag) it may be difficult to excavate the contaminated soil. Also, excavation near and between buildings on-site may require the use of specialized equipment. Sufficient area is available at the site for staging wastes. Excavation, off-site transportation to the TSD facility, and site restoration would be performed with moderate difficulty due to the excessive volume of the source material and the large size of the slag "boulders." There is some level of difficulty in the implementation of Alternative SL4. The first difficulty is locating an appropriate disposal facility for the excessive volumes of excavated soil. Also, there may be difficulty if the water table (i.e. groundwater) or river water is encountered during excavation of soils along the shorelines and throughout the RSC, as it may involve pumping water from excavations or dewatering soils from the deeper excavations. Implementation of this alternative would require public access restriction to the site during the remediation process.

Cost: The present worth cost of this alternative is $649,931,000.

Conclusion: This alternative meets the RAOs, includes complete source (i.e., soil, slag) removal, and can be implemented. Therefore, this alternative would be retained for detailed evaluation.

3.5.1.5 Alternative SL5: Excavation /Soil Washing/On-Site Backfill

Description: This alternative consists of excavation of contaminated soils, on-site treatment by soil washing, and on-site backfilling of treated soil into the excavation areas. The treated soil would be tested to ensure that the cleanup levels have been met and that it meets applicable requirements for on-site backfill. Erosion control/stormwater management would also be included.

Effectiveness: Excavation and soil washing of on-site contaminated soils and slag would reduce the public health risks associated with direct contact with the contaminants. Treated soil should meet NJDCSCC for backfill. Excavation and soil washing would also eliminate the risks to ecological receptors and would result in overall protection of human health and the environment. This alternative would comply with all chemical-specific ARARs/TBCs, since washed soils would only be used as backfill if these requirements were met. Likewise, all remedial activities would be conducted in accordance with location- and action-specific ARARs. Due to the proximity of surface water bodies and wetlands, waivers for some location-specific ARARs may be needed to conduct remedial activities in these areas. Soil washing would reduce the risk caused by inorganic contaminants because it reduces their concentrations and leaves minimal residual concentration on-site. However, soil washing is not sufficiently effective due to the heterogeneity of the soil and slag material. The washed soils would be backfilled in the excavation areas.

Implementability: All the components of this alternative are well developed and commercially available for implementation at the site. However, a moderate amount of difficulty is encountered due to the excessive volume of material and the large size of the slag "boulders." Excavation utilizes common construction equipment and should pose no availability problems. Soil washing of inorganic contaminants has been demonstrated and proven, and on-site equipment is readily available. Sufficient area is available at the site to operate soil washing equipment. Implementation of this alternative would require restriction of site access during the remediation process. A large quantity of wastewater is generated from soil washing activities, which would require treatment and discharge. Although no permits would need to be obtained for on-site remediation, the substantive requirements for the permits would have to be satisfied.

There is some level of difficulty in the implementation of Alternative SL5. There may be difficulty if the water table (i.e. groundwater) or river water is encountered during excavation of soils along the shorelines and throughout the RSC, as it may involve pumping water from excavations or dewatering soils from the deeper excavations.

Cost: The present worth cost of this alternative is $276,306,000.

Conclusion: Prior to performing treatability studies, it is not clear as to how much material would meet backfill requirements and how much material would require off-site disposal. Soil washing generates large quantities of wastewater and is not easily implemented with heterogeneous soil and slag material; thus, it would not be retained for detailed evaluation.

3.5.1.6 Alternative SL6: *In Situ* Stabilization/Containment

Description: This alternative includes *in situ* stabilization of the contaminated soil and slag material. The inorganic contaminants of concern would be bound within the cementitious matrix. Since the stabilized soils and slag material would be left in the ground (i.e., *in situ*), the site would undergo five-year reviews. The stabilized areas would be restored to original conditions by capping with a soil cover. Erosion control/stormwater management would also be included.

Effectiveness: Stabilization would reduce the exposure risks associated with the migration of inorganic contaminants and would result in overall protection of human health and the environment. The toxicity of inorganic contaminants may remain unaltered; however, mobility of these contaminants would be substantially reduced. Capping of contaminated soil would eliminate the human health and ecological exposure risks as long as the capped areas were maintained and future activities did not disrupt these contained areas. This alternative would comply with all ARARs/TBCs. Due to the proximity of surface water bodies and wetlands to the site, waivers for some location-specific ARARs may be needed.

Implementability: All the components of this alternative are well developed and commercially available for implementation at the site, although activities near and between the buildings may require special consideration. Furthermore, it is difficult to stabilize the Slag Disposal Area due to the excessive volume and cumbersome size of the slag "boulders." *In situ* stabilization of inorganic contaminants has been demonstrated and proven, and equipment is readily available, since it utilizes common construction equipment and should pose no problems. In addition, containment via soil capping is well developed, readily available, and easily implementable.

Cost: The present worth cost of this alternative is $118,656,000 for Option (a) and $117,008,000 for Option (b).

Conclusion: Due to the extremely large volumes of soil and slag material, the degree to which contaminants are left in place, the unknown long-term stability, as well as the 30 percent volume increase from the stabilization additives that may require some off-site disposal, this alternative would not be retained for detailed evaluation.

3.5.2 Screening of Sediment Alternatives

Each of the sediment alternatives is sufficiently different from the others and each is capable of addressing the risks at the site (with the exception of No Action). Therefore, all of the sediment alternatives developed are retained for detailed evaluation in Section 4.0.

3.5.3 Screening of Groundwater Alternatives

3.5.3.1 Alternative GW1: No Action

Description: This alternative includes five-year site reviews and is used as a baseline for which the other alternatives are compared.

Effectiveness: No Action is minimally effective since all of the contamination remains on-site, and neither ARARs nor TBCs are satisfied. In addition, there is no protection of human health, there is no reduction in toxicity, mobility, nor volume, and both the environment and wildlife would continue to be impacted from the existing conditions. However, there are no increased risks to the community or site workers.

Implementability: This alternative is highly implementable, since there is no major construction, treatment, equipment, materials, nor monitoring involved. The five-year site reviews are easily implementable.

Cost: The cost is very low since there are no capital costs. The present worth cost of $54,000 is incurred from the five-year site reviews.

Conclusion: In accordance with CERCLA requirements, the No Action Alternative is retained for detailed evaluation as a baseline for comparison of other alternatives.

3.5.3.2 Alternative GW2: Limited Action

Description: This alternative includes implementing five-year site reviews, long-term monitoring, water use restrictions, and establishment of a Classification Exception Area (CEA). The long-term monitoring program would be performed in accordance with a Long-Term Monitoring Plan following adequate delineation of the groundwater plume.

Effectiveness: Limited Action is minimally effective since all of the contamination remains on-site, institutional controls are unreliable, chemical-specific ARARs are not satisfied, there is some protection of human health, but no protection of the environment since the potential for contaminant migration still exists. Over time, through natural processes, contaminant concentrations would eventually decline. However, the time needed to reach acceptable risk levels is 90,000 years, based on the flow modeling.

Implementability: The CEA could be easily implemented. Any additional security measures can be easily accomplished. The monitoring equipment and analytical laboratory services are commercially available and proven.

Cost: The present worth cost of this alternative is $686,000.

Conclusion: Since the well restrictions and long-term monitoring would mitigate human health risks associated with exposure to contaminated groundwater and RAOs are met, this alternative is retained for detailed evaluation.

3.5.3.3 Alternative GW3: Containment

Description: This alternative combines vertical subsurface barrier walls, to prevent off-site contaminant migration, and hydraulic control to prevent groundwater mounding and head build-up behind the walls. The long-term monitoring program would be performed in accordance with a Long-Term Monitoring Plan following adequate delineation of the groundwater plume.

Effectiveness: This alternative achieves the RAOs of protecting human health and ecological receptors by reducing contaminant migration and exposure to the groundwater along the 2,000-foot barrier wall. However, it does not eliminate the source of contamination, therefore it does not satisfy any of the identified chemical-specific ARARs. Location- and action-specific ARARs would be followed or waivers would need to be obtained as necessary. Water use restrictions and a CEA would still be needed. This alternative involves the extraction, treatment, and discharge of a large volume of contaminated groundwater. However, since only a portion of the groundwater plume is captured, cleanup levels would not be achieved site-wide. Thus, toxicity and volume would only somewhat decrease and potential long-term adverse environmental impacts would still exist. Over time, through natural processes, contaminant concentrations would eventually decline. However, the time needed to reach acceptable risk levels is unknown.

Implementability: This alternative would utilize common construction equipment and readily available system equipment (e.g., pumps). All the components of this alternative are well developed and commercially available for implementation at the site and it is expected that equipment contractors and vendors would continue to be available at the time of implementation. Also, adequate space is available for staging areas during the construction of the containment barriers and installation of the hydraulic control system.

Cost: The present worth cost of this alternative is $15,431,000.

Conclusion: Hydraulic control is very sensitive to the physical properties of the cutoff wall, in terms of hydraulic conductivity, thickness, and wall configurations. In addition, the pumping rate is 70 gpm, which is not substantially different than the 93 gpm pumping rate for the restoration alternative (i.e., GW4). Due to the 70 gpm rate and incremental equipment sizes, this alternative would also require a similar-sized treatment system to that discussed in Alternative GW4. However, only a portion of the contaminant plume is controlled and treated. Furthermore, extra costs are incurred, in comparison to GW4, because of cutoff wall construction. Therefore, this alternative would not be retained for detailed evaluation.

3.5.3.4 Alternative GW4: Restoration

Description: This alternative includes groundwater restoration via extraction wells for a pump-and-treat system. The 100 gpm groundwater treatment system would include several process options, such as extraction, equalization, precipitation, filtration, adsorption, and neutralization, for the removal of certain contaminants. There are two options associated with this alternative: Option (a) which includes source removal and Option (b) which does not include source removal. Source removal consists of excavating all of the impacted soils from the main plant area (OU-5) and all of the material in the Slag Disposal Area (OU-3) which exceed the ARARs/TBCs (i.e., Soil Alternative SL4). The long-term monitoring program would be performed in accordance with a Long-Term Monitoring Plan following adequate delineation of the groundwater plume.

Effectiveness: This alternative is effective since it is protective of human health, exposure pathways are controlled, further adverse impacts to the environment are mitigated, and all ARARs are satisfied. Not only is there a reduction in toxicity, mobility, and volume of contaminants, but the treatment remedy is permanent and irreversible. However, it would take 35,000 years to achieve cleanup levels, if all sources are removed.

Implementability: All the components of this alternative, including Option (a), are well developed and commercially available for implementation at the site, and it is expected that equipment contractors and vendors would continue to be available at the time of implementation. In addition, sufficient land is available at the site for the groundwater treatment system. This alternative would utilize common construction equipment, readily available process units, and commercially-available excavation equipment, if Option (a) is used. It is anticipated that no implementation problems would be encountered.

Cost: The present worth cost of this alternative is $13,043,000.

Conclusion: This technology is technically feasible for groundwater extraction and treatment. In addition, source removal via Option (a) would provide additional protection to human health and the environment, since the contamination would be removed from the site. For the above reasons, this alternative is retained for detailed evaluation as a groundwater remedy.

4.0 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents a detailed evaluation of the remedial alternatives developed in Section 3.0. The remedial alternatives have been examined with respect to the requirements stipulated in CERCLA as amended, "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" Interim Final (USEPA, 1988a) and "Technology Screening Guide for Treatment of CERCLA Soils and Sludges" (USEPA, 1988b). Section 4.1 discusses the evaluation process used and the criteria against which the remedial actions are analyzed. Sections 4.2, 4.3, and 4.4 present the results of the evaluation of each alternative with respect to the criteria for contaminated soils, sediments, and groundwater, respectively. Sections 4.5, 4.6, and 4.7 present a comparison among remedial alternatives for soils, sediments and groundwater, respectively.

4.1 EVALUATION CRITERIA

As outlined in the USEPA RI/FS Guidance (USEPA, 1988a) the remedial alternatives that passed the initial screening in Section 3.0 are evaluated using the following nine criteria:

1. Overall Protection of Human Health and the Environment
2. Compliance with ARARs
3. Long-Term Effectiveness
4. Reduction of Toxicity, Mobility or Volume
5. Short-Term Effectiveness
6. Implementability
7. Cost
8. State Acceptance
9. Community Acceptance

These nine criteria are described below.

Overall Protection of Human Health and the Environment

This evaluation criterion provides an overall assessment of protection based on a composite of factors such as long-term and short-term effectiveness and compliance with ARARs. Evaluations of the overall protectiveness address:

- How well a specific site remedial action achieves protection over time;
- How well site risks are reduced; and
- How well each source of contamination is eliminated, reduced, or controlled for each remedial alternative.

Compliance with ARARs

This evaluation criterion is used to determine how each remedial action complies with applicable or relevant and appropriate Federal and State requirements as defined in CERCLA Section 121. Each alternative is evaluated in detail for:

- Compliance with chemical-specific ARARs (e.g., MCLs);
- Compliance with action-specific ARARs (e.g., RCRA minimum technology standards);
- Compliance with location-specific ARARs (e.g., Wetlands Protection at Superfund Sites); and
- Compliance with appropriate criteria, advisories, and guidances (i.e., TBC material).

Section 2.2.1 presents an overall list of ARARs and TBCs material that were used to evaluate the remedial alternatives. Specific statutory or regulatory citations and their applications to the remedial alternative evaluations are contained in Sections 4.2, 4.3, and 4.4.

Long-Term Effectiveness

This evaluation criterion addresses the results of the remedial action in terms of the potential risk remaining at the site after the RAOs have been met. The components of this criterion include the magnitude of the remaining risks; the adequacy and suitability of controls used to manage treatment residuals or untreated wastes; and the long-term reliability of management controls for providing continued protection from residuals; i.e., the assessment of potential failure of the technical components.

Reduction of Toxicity, Mobility or Volume

This evaluation criterion addresses the statutory preference that treatment is used to result in the reduction of principal threats of the total mass of toxic contaminants, the irreversible reduction in contaminant mobility, or the reduction of the total volume of contaminated media. Factors to be evaluated in this criterion include the treatment process employed; the amount of hazardous material destroyed or treated; the degree of reduction in toxicity, mobility or volume expected; and the type and quantity of treatment residuals.

Short-Term Effectiveness

This evaluation criterion addresses the impacts of the action during the construction and implementation phase until the RAOs have been met. Factors to be evaluated include protection of the community during the remedial actions, protection of workers during the remedial actions, environmental impacts resulting from the implementation of the remedial actions, and the time required to achieve protection.

Implementability

This criterion addresses the technical and administrative feasibility of implementing a remedial action and the availability of various services and materials required during its implementation. *Technical feasibility* factors include construction and operation difficulties, reliability of technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy. *Administrative feasibility* includes the ability and time required for permit compliance and for activities needed to coordinate with other agencies. Factors employed in evaluating the *availability of services and materials* include availability of treatment, storage, and disposal services with required capacities; availability of equipment and specialists; and availability of prospective technologies for competitive bid.

Cost

The types of costs that would be addressed include: capital costs, operation and maintenance (O&M) costs, costs of five-year reviews (where required), and present value of capital and O&M costs. Capital costs consist of direct and indirect costs. Direct costs include expenditures for the equipment, labor, and materials necessary to install remedial actions. Indirect costs include expenditures for engineering, financial, and other services required to complete the installation of remedial alternatives. Annual O&M costs include auxiliary materials and energy, disposal of residues, purchased services, administrative costs, insurance, taxes, license costs, maintenance reserve and contingency funds, rehabilitation costs, and costs for long-term monitoring.

This assessment evaluates the costs of the remedial actions on the basis of present worth. Present worth analysis allows remedial actions to be compared on the basis of a single cost representing an amount that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life. A required operating performance period is assumed to calculate present worth cost, which is also a function of the discount rate. A 30-year period and a discount rate of seven percent are used for a base calculation. The discount rate represents the anticipated difference between the rate of investment return and inflation. The "study estimate" costs provided for the remedial actions have an accuracy of -30 to +50 percent.

State Acceptance

This assessment evaluates the technical and administrative issues and concerns the State may have regarding each of the remedial alternatives. The factors to be evaluated include features of the actions that the state either supports, has reservations about, or opposes.

Community Acceptance

This assessment incorporates public comments received during the required public meeting and comment period into the analysis of the remedial alternatives.

In the following sections, each remedial alternative is evaluated with respect to the first seven evaluation criteria. The state has reviewed the document and provided input during preparation of the FS. However, they have not formally accepted nor rejected the remedial alternatives. The public has not been provided with a formal opportunity to review the detailed analysis of the remedial alternatives. No formal comments from the State or the public are available for evaluation of the "State Acceptance" and "Community Acceptance" criteria in this FS Report. It is anticipated that the formal comments from the public would be provided during the 30-day comment period for the administrative record. These comments would then be addressed in the ROD and the responsiveness summary. At the completion of the detailed analysis, comparative evaluation are included (Sections 4.5, 4.6, and 4.7), wherein the criteria are compared to one another for each remedial alternative to assist in the remedy selection process.

4.2 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES FOR SOILS

This section presents a description and the results of the analysis of alternatives against the first seven evaluation criteria for each of the following soil alternatives that passed initial screening:

Alternative SL1: No Action
Alternative SL2: Limited Action
Alternative SL3: Containment
Alternative SL4: Source Removal/Off-Site Disposal

4.2.1 <u>Alternative SL1: No Action</u>

4.2.1.1 Description

This alternative includes no remedial activities at the site. All contamination would remain and five-year reviews would be performed to assess the risk posed by the soil contamination.

4.2.1.2 Evaluation

<u>Overall Protection of Human Health and the Environment</u>: The No Action alternative would not entail removal or other on-site containment or treatment of the contaminated soil. Therefore, it would not provide adequate protection of human health and the environment since there would not be any immediate reduction in the toxicity, mobility or volume of the contaminants. The risk of direct contact with contaminated soils and associated ecological risks would not be controlled. The potential for site access and direct contact exposure risks would continue.

<u>Compliance With ARARs</u>: The No Action alternative does not comply with ARARs. Since no attenuation of contamination is achieved, chemical-specific ARARs are not satisfied. Since no site closure or remediation is accomplished, RCRA is not satisfied (an action-specific ARAR).

<u>Long-Term Effectiveness</u>: The No Action alternative would not result in attainment of target cleanup levels. Although it is not possible to determine the time required for natural attenuation without comprehensive contaminant modeling, it is estimated that an indefinite time period would be required before natural degradation and transport mechanisms significantly reduce the toxicity and

concentration of contaminants in the soil. Natural attenuation typically includes dilution, dispersion, and biodegradation of constituents over time; however, biodegradation would not contribute to natural attenuation because of the many inorganic contaminant levels at this site.

The long-term effectiveness of the alternative in minimizing baseline human health risks through the potential exposure pathways would depend on its success in preventing access to the site. The existing security fence is not intact in all contaminated areas and there is the possibility of access to portions of the contaminated areas. In addition, inhalation of airborne dust would continue. Ecological receptors at the RSC would continue to be impacted by contaminated soil.

Reduction of Toxicity, Mobility or Volume: This alternative would not involve any containment, removal, treatment or disposal of the contaminated soils. Therefore, this alternative would not result in any immediate reduction in the toxicity, mobility or volume of contaminants. Over time, through natural attenuation, contaminant concentrations may eventually decline.

Short-Term Effectiveness: No construction would be involved in this alternative. There would be no additional short-term threats to neighboring communities and no significant impacts on public health from the implementation activities. Workers performing site inspection activities would be potentially exposed to contaminated soil. Workers would require personal protective equipment to minimize the risks of direct contact. This alternative would not result in any short-term improvement over current conditions. Contaminants would persist at the site. As no design or construction are involved in this alternative, it would not take any time to implement.

Implementability:

Technical Feasibility

No remedial action is employed in this alternative. Remedial action can be easily undertaken. However, it may be necessary to go through the RI/FS/ROD process again.

Administrative Feasibility

Long-term institutional management would be associated with this alternative since contaminants would remain on site and review would be necessary every five years.

Availability of Services and Materials

This alternative does not involve any treatment, storage or disposal services.

Cost: There is no capital cost or annual O&M cost for the No Action alternative. The cost of five-year reviews for the site for a 30-year period has a present worth of $54,000 based on $25,000 per review and a seven percent discount rate. Cost breakdowns are provided in Table 4-1. Data in support of these cost estimates are presented in Appendices B and C. The allocation of cost to the soil and Slag Disposal Area is presented in Table C-35 in Appendix C.

TABLE 4-1 (Sheet 1 of 5)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
COMPARISON OF ALTERNATIVES FOR SOILS

Criteria	Alternative SL1 No Action	Alternative SL2 Limited Action	Alternative SL3 Containment	Alternative SL4 Source Removal/Off-Site Disposal
Key Components	5-year reviews, site inspections, fence maintenance, and agency coordination.	Long-term soil monitoring, 5-year reviews, institutional controls, erosion control/stormwater management security guard services, fence around contaminated areas, and NJDEP DER.	A combination of soil capping and/or asphalt capping to contain contaminated soils and NJDEP DER.	Source removal and off-site disposal, fill with clean soil.
1. Overall Protection of Health and the Environment	Provides no protection of human health since contaminants remain on-site. Does not protect the environment.	Provides little protection of human health since contaminants remain on-site and institutional controls may be ineffective. Does not protect the environment.	Provides protection of human health and the environment by eliminating contaminant exposure routes for human and ecological receptors.	Achieves overall protection of human health and the environment. Excavation would destroy vegetation and disturb wildlife, but impacts would be temporary.
2. Compliance with ARARs/TBCs				
• Chemical-Specific ARARs/TBCs	Would not comply with chemical-specific TBCs, since contaminants are not removed.	Would not comply with chemical-specific TBCs, since contaminants are not removed.	Would not comply with chemical-specific TBCs, since contaminants are not removed. Subsurface soils would still exceed TBCs.	Would comply with all chemical-specific TBCs since contaminants are removed.
• Action-Specific ARARs	Not applicable.	Not applicable.	Would be performed in accordance with action-specific ARARs.	Would be performed in accordance with action-specific ARARs.
• Location-Specific ARARs	Not applicable	Not applicable.	Would be performed in accordance with location-specific ARARs.	Would be performed in accordance with location-specific ARARs.
• Compliance with criteria advisories, and guidances	Not applicable.	Not applicable.	Would be in compliance with federal, state and local criteria, advisories and guidances.	Would be in compliance with federal, state and local criteria, advisories and guidances.
3. Long-Term Effectiveness				
• Magnitude of residual risks	Source has not been removed. Existing risk would remain. Eventually natural processes may decrease risk.	Source has not been removed. Existing risk would remain. Eventually natural processes may decrease risk.	Would eliminate human health and ecological risks. However, the contamination would remain on-site.	Would eliminate human health and ecological risks. Source removal is permanent and irreversible.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
COMPARISON OF ALTERNATIVES FOR SOILS

Criteria	Alternative SL1 No Action	Alternative SL2 Limited Action	Alternative SL3 Containment	Alternative SL4 Source Removal/Off-Site Disposal
3. Long-Term Effectiveness (Cont'd)				
• Adequacy of controls	Part of contaminated area not fenced. Requires 5-year reviews.	Institutional controls provide more protection than no action, but no guarantee against exposure.	Exposure to contaminated soil reduced. However, contaminants remain on-site. Long-term monitoring and a DER will be required.	Exposure to contaminated soil is eliminated, since all contaminated soil and slag are removed.
• Reliability of Control	Existing fence and monitoring wells are susceptible to vandalism; existing fence does not enclose all contaminated areas. These measures are not fully protective.	Existing fence and monitoring wells are susceptible to vandalism; existing fence does not enclose entire contaminated area. Additional fencing will be installed. Institutional controls can be violated.	Containment technologies applied to cap soils are reliable. Caps must be maintained on a regular basis.	Permanent/irreversible control.
4. <u>Reduction of Toxicity, Mobility and Volume</u>				
• Treatment process and remedy	No treatment employed.	No treatment employed.	Containment of contaminated soil with soil or asphalt capping.	Source removal via excavation.
• Amount of hazardous material destroyed or treated	None by treatment. Natural processes continue to take place resulting in lower levels of contamination; however, this would take an extremely long time.	None by treatment. Natural processes continue to take place resulting in lower levels of contamination; however, this would take an extremely long time.	Paving of 177,000 square yards of soil and soil covering of 414,,000 square yards (Option a) or soil covering of entire 591,000 square yards (Option b). For slag containment, both Option (a) and Option (b) include 165,000 square yards of soil cover. No destruction of contaminated soil.	860,000 cubic yards of soil and 710,000 cubic yards of slag to be excavated and disposed of off-site. Treatment if necessary for LDRs.
• Reduction of toxicity, mobility and volume	None by treatment. Natural migration might increase volume of contaminated soil and groundwater. No change in mobility.	None by treatment. Natural migration might increase volume of contaminated soil and groundwater. No change in mobility.	Does not reduce toxicity or volume. Mobility may be decreased if caps are properly maintained.	Significantly reduces toxicity, mobility, and volume.
• Type and quantity of treatment residues	No treatment involved.	No treatment involved.	No treatment residues are generated on-site.	No treatment residues are generated on-site.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
COMPARISON OF ALTERNATIVES FOR SOILS

Criteria	Alternative SL1 No Action	Alternative SL2 Limited Action	Alternative SL3 Containment	Alternative SL4 Source Removal/Off-Site Disposal
5. Short-Term Effectiveness				
• Protection of community during remedial actions	There are no remedial actions. Risk to community not increased. No protection required.	There are no remedial actions. Risk to community not increased. No protection required.	Limited risk due to minimal disturbance of contaminated soil and capping.	Dust control and air emissions controls required for excavation and soil handling.
• Protection of workers during remedial actions	No significant risk to inspectors.	Protection required against dermal contact, inhalation and ingestion of contaminated soil.	Protection required against dermal contact, inhalation and ingestion of contaminated soil.	Protection required against dermal contact, inhalation and ingestion of contaminated soil.
• Environmental impacts	Continued impact from existing conditions. Wildlife continues to be impacted.	Continued impact from existing conditions. Wildlife continues to be impacted.	Clearing of vegetation required. May impact terrestrial habitats.	Potential air quality impacts from soil handling. Clearing of vegetation required. May impact terrestrial habitats.
• Time until remedial response objectives are achieved	No time to implement; however, remedial objectives not achieved.	Six months to one year required to implement.	Planning, design, and procurement estimated to be one to two years. Subsequent capping and restoration period estimated to be one to two years.	Planning, design, and procurement estimated to be one to two years. Subsequent remediation period is estimated to be two to three years.
6. Implementability				
Technical Feasibility				
• Ability to construct and operate technology	No construction involved.	No major construction involved (e.g., fence). Institutional controls are technically implementable.	Containment is a commonly used and proven technology.	Excavation is an implementable and proven technology. However, excavation in the building area may be difficult due to their close proximity to each other and excavation of the slag material may also be difficult.
• Reliability of Technology	No treatment technology involved.	No treatment technology involved. Monitoring is reliable.	Containment is a reliable technology.	Source removal and off-site disposal are reliable technologies.

TABLE 4-1 (Sheet 4 of 5)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
COMPARISON OF ALTERNATIVES FOR SOILS

Criteria	Alternative SL1 No Action	Alternative SL2 Limited Action	Alternative SL3 Containment	Alternative SL4 Source Removal/Off-Site Disposal
6. Implementability (Cont'd)				
• Ease of undertaking additional remedial action, if necessary	If review indicates that more action is necessary, may need to go through the RI/FS/ROD process again.	If monitoring and/or review indicates that more action is necessary, may need to go through the RI/FS/ROD process again.	Containment materials can be added and maintained if necessary. Other actions (e.g., excavation of contaminated soils) may require disturbance of the containment system.	Additional excavation is technically implementable, if required.
• Monitoring Considerations	None provided.	A long-term soil monitoring program is associated with this alternative.	Long-term monitoring is not associated with this alternative.	Long-term monitoring would not be required as contamination is completely removed from the site.
Administrative Feasibility				
• Coordination with other agencies	Coordination required with all agencies for long periods of time for reviewing the site.	Coordination required with all agencies for long periods of time for monitoring and reviewing the site. Additional coordination needed for institutional controls (e.g., DER).	Coordination with local agencies required for long-term monitoring, site reviews, and a DER.	Coordination with local agencies may be required for off-site transportation of excavated material.
Availability of Services and Materials				
• Availability of treatment, storage capacity, and disposal services	No treatment, storage or disposal facilities required.	No treatment, storage or disposal facilities required.	No treatment, storage or disposal facilities required.	Off-site disposal facilities are available, although they may be difficult to locate because of the excessive volumes of excavated soil.
• Availability of necessary equipment, specialists and materials	None required.	Equipment and specialists for monitoring are readily available locally.	Containment services and equipment are available.	Local services and equipment are available.
• Availability of technologies	None required.	None required.	Several alternatives are available for containment.	Alternatives are available for off-site disposal.

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TABLE 4-1 (Sheet 5 of 5)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
COMPARISON OF ALTERNATIVES FOR SOILS

Criteria	Alternative SL1 No Action	Alternative SL2 Limited Action	Alternative SL3 Containment	Alternative SL4 Source Removal/Off-Site Disposal
7. Costs				
• Total Capital Cost ($)	$0	$1,731,000	$20,092,000 (Option a) $16,839,000 (Option b)	$649,931,000
• Annual operation and maintenance cost ($/yr)*	$0	$318,000	$212,000 (Option a) $178,000 (Option b)	$0
• Present worth of operation and maintenance ($)**	$54,000	$4,138,000	$4,330,000 (Option a) $3,640,000 (Option b)	$0
• Present worth ($ based on 7 percent discount rate and 30 year period)	$54,000	$5,869,000	$24,422,000 (Option a) $20,479,000 (Option b)	$649,931,000

*Annual O&M excludes 5-year reviews and one-time contingency in year 3.
**Present worth of O&M includes 5-year reviews and one-time contingency in year 3.

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4.2.2 Alternative SL2: Limited Action

4.2.2.1 Description

The Limited Action alternative for the soil and slag would consist of continuing site security measures, performing long-term soil monitoring, and restrictions on land use. Existing fencing would be maintained on the site enclosing all contaminated soil areas to prevent access. Warning signs would be posted along the perimeter of the site identifying the area as containing hazardous materials. For the purpose of erosion control and stormwater management, this alternative would also include dust suppression, site re-grading, and seeding or vegetation.

Because this alternative does not include treatment and/or removal, long-term monitorig would be performed and the site would be reviewed every five years for a period of 30 years per requirements of CERCLA as amended. These five-year reviews would include the reassessment of human health and environmental risks due to the contaminated material left on site.

Overall Protection of Human Health and the Environment: This alternative would not meet the remedial action objectives for soil. The contaminated materials would not be removed; contained or treated. Institutional controls would reduce the likelihood of exposure to contaminated soils, but could not guarantee that no exposures would occur.

Compliance with ARARs: This alternative does not eliminate the source of contamination. It does not satisfy any of the identified chemical-specific ARARs/TBCs. Location- and action-specific ARARs are not applicable to Limited Action.

Long-Term Effectiveness: The Limited Action alternative would very slowly reduce the level of contamination from the source area by natural attenuation. Natural attenuation typically includes dilution, dispersion, and biodegradation of constituents over time; however, biodegradation would not contribute to natural attenuation because of the many inorganic contaminant levels at this site. Natural attenuation is a very slow process, and it would take a very long period of time to achieve the designated soil cleanup criteria for the contaminants.

The implementation of this alternative would not have any beneficial effects on the environment. Potential long-term adverse environmental impacts do exist because the contaminated soils would remain on site. The potential for contaminant migration through leaching (i.e., volume of contamination increases) and chemical release from soil through air entrainment of dust particles still remains. Maintenance of the security fence, security guard services, public education programs and land use restrictions would minimize exposure risk to the community. However, inhalation of airborne dust would continue. Ecological receptors at the site would continue to be impacted by contaminated soil.

Reduction of Toxicity, Mobility or Volume: This alternative does not involve any containment, removal, treatment or disposal actions for contaminated soil. In addition, the mobility of the contaminants would remain unchanged; therefore, the potential to continue to act as a source of groundwater contamination exists. Over time, through natural processes, contaminant concentrations would slowly decline. However, the time needed to reach acceptable risk levels is unknown.

Short-Term Effectiveness: The Limited Action alternative would not achieve any of the remedial action objectives. No major construction would be involved in this remedial alternative; therefore, there are no additional short-term threats to neighboring communities and no significant impacts on public health and the environment from implementation activities. A minor potential exists for site assessment personnel to contact contaminated soil during monitoring. However, this would be mitigated by wearing the appropriate personal protective equipment (PPE). Institutional programs and security measures such as fencing could be instituted in approximately six months to one year.

Implementability:

Technical Feasibility

The land use restrictions, a long-term soil monitoring program, and erosion control/stormwater management measures would be technically implementable. Installation of a fence and other security measures would be readily implemented.

Administrative Feasibility

Considerable long-term institutional management would be associated with this alternative for maintenance of institutional controls, and the long-term soil monitoring program and five-year reviews. NJDEP requirements for a DER would have to be met.

Availability of Services and Materials

The monitoring equipment is commercially available and proven. Services and materials required for security measures and site monitoring and sampling are readily available in the area. Numerous vendors would be available for competitive bids.

Cost: The total present worth, calculated based on a discount rate of seven percent and a 30-year period is $5,869,000. Cost breakdowns are provided in Table 4-1. Data in support of these cost estimates are presented in Appendices B and C. The allocation of cost to the soil and Slag Disposal Area is presented in Table C-35 in Appendix C.

4.2.3 Alternative SL3: Containment

4.2.3.1 Description

This alternative consists of containment of all contaminated soil and slag by capping. Soil and asphalt caps would be used on different portions of the site, or a soil cap would be used over the entire site (Options (a) and (b), respectively), to contain contaminants and eliminate the exposure routes of concern.

4.2.3.2 Evaluation

Overall Protection of Human Health and the Environment: Containment of contaminated soil provides protection of human health and the environment by eliminating the soil exposure pathways for human and ecological receptors. The protection would persist only as long as the containment measures were actively maintained, since contaminants would remain and a breach of containment measures could re-establish human and/or ecological exposure routes.

Compliance with ARARs: All activities for this alternative would be performed in accordance with location and action-specific ARARs. Waivers would be sought, if necessary, based on technical impracticality of complying with certain ARARs. Efforts would be made to protect wetlands, coastal areas, and endangered species in accordance with State and Federal ARARs, such as the Protection of Wetlands Executive Order, Wetlands Protection at Superfund sites, the Wetlands Act of 1970, the Freshwater Wetlands Protection Act Rules, the Endangered Species Act, etc. Substantive requirements of ARAR federal and state waste management regulations regarding capping of wastes would be met. This alternative would not comply with chemical-specific TBCs such as USEPA SSLs and NJDEP soil cleanup criteria, since contaminants are not removed to cleanup levels. It would, however, eliminate exposure pathways associated with those contaminants.

Long-Term Effectiveness: Capping of contaminated soil would eliminate the human health and ecological exposure risks as long as the capped areas were maintained and future activities did not disrupt the capped areas, thereby re-establishing exposure routes. Since the contamination is left in place, the potential exists for migration of contaminants into groundwater and/or surface water and the establishment of new exposure routes; therefore, long-term monitoring and a DER would be required for this alternative.

Reduction of Toxicity, Mobility or Volume: This alternative would not result in any reduction of toxicity, mobility or volume through treatment. Areas that are capped with impermeable materials (i.e., asphalt over soil) may exhibit some reduction in mobility of contaminants via infiltration and/or erosion, but only if these caps are maintained. Areas covered with clean soil may exhibit a lesser reduction.

Short-Term Effectiveness: During implementation of this alternative, workers could potentially be exposed to contaminants in site soils. This risk would be minimized by use of appropriate PPE to prevent contact and inhalation. There is also the potential for nearby populations to be exposed to contaminated material and/or fugitive dust. The RSC would be secured during construction activities to prevent unauthorized access, and fugitive dust should be minimal, since no contaminated soil would be significantly disturbed during implementation (i.e., all cap materials would be certified as non-contaminated). Precautions would be used during site preparation (such as clearing and grubbing) and cap installation in order to minimize dust.

Environmental impacts during implementation of this alternative would include: increased traffic and noise resulting from importing cover material from an off-site source and disturbance of vegetated areas. Vegetation would be re-established in those areas that are capped with soil. Vegetation would be permanently removed from areas that are capped with asphalt.

Planning, design, and procurement of resources for this alternative would take approximately one to two years. Construction work associated with the containment alternative is estimated to take one to two years.

Implementability:

Technical Feasibility

All the components of this alternative are well developed and commercially available and capping is an easily implementable technology. Long-term monitoring and maintenance would also be required.

Administrative Feasibility

Implementation of this alternative would require continued restrictions on site access during construction. Since contamination would remain on site, a DER or other type of deed restriction would be required which specifies future uses of the site, which would not re-establish exposure routes. These restrictions could require the cooperation of and/or negotiations with future property owners.

Availability of Services and Materials

Construction services for cap construction are readily available as these represent conventional construction activities. Materials for capping are also available, but careful planning and coordination would be required to ensure that adequate quantities of material were available and transported to the RSC for efficient implementation of this alternative because of the large quantities required.

Cost: The total present worth, calculated based on a discount rate of seven percent and a 30-year period is $24,422,000 for Option (a) and $20,479,000 for Option (b). Cost breakdowns are provided in Table 4-1. Data in support of these cost estimates are presented in Appendices B and C. The allocation of cost to the main plant and Slag Disposal Area is presented in Table C-35 in Appendix C.

Preparation of design documents for OU-3, (i.e., the slag area) proceeded after issue of the OU-3 ROD and a 65% design cost estimate was prepared. The 65% design estimate was $11,681,578, and included costs for navigation towers and a replacement wharf, and also included contingency, engineering, legal and administrative costs at 41% of direct capital cost. Eliminating the navigation tower and wharf costs, and reducing the indirect costs to 40% (as used in this FS), the 65% cost estimate for the slag area would be approximately $8,370,000. Although higher than the cost allocated to the slag area in this FS, the adjusted 65% design estimate is within the approximate stated accuracy of the FS estimate. In addition, the FS estimate for the slag area reflects savings that will be realized by performing remediation of the main plant and slag areas together.

4.2.4 Alternative SL4: Source Removal/Off-Site Disposal

4.2.4.1 Description

This alternative consists of complete source removal of the contaminated soil and slag material. Using the most stringent ARARs/TBCs as criteria, source removal would be performed to the deepest depth where these exceedances were detected. As presented in Appendix A, there are 66 main plant soil areas (OU-5) that would be excavated to 4 feet bgs. The remaining eight areas would be excavated to depths of 8 to 10 feet bgs. Excavated material would be transported off-site for proper disposal. Clean fill would be used to restore excavated areas and all areas would be revegetated.

4.2.4.2 Evaluation

Overall Protection of Human Health and the Environment: The excavation and removal of contaminated soil from the site would eliminate the potential human health and ecological risks associated with exposure to contaminated soils. The mobility of hazardous contaminants in the site soil would also be reduced. This alternative would result in overall protection of human health and the environment.

Compliance with ARARs: This alternative would comply with ARARs, or waivers would be obtained as necessary. Location-specific ARARs would be addressed as discussed for Alternative SL3. In addition, substantive requirements of ARARs would be complied with for excavation of wastes. This alternative would comply with chemical-specific TBCs such as USEPA SSLs and NJDEP soil cleanup criteria, since contaminants are removed to cleanup levels. Direct contact risks would be reduced.

Long-Term Effectiveness: The excavation and removal of contaminated soil and slag would reduce the potential human health risks associated with direct contact with contaminated soils. Excavated soil and slag would be replaced by clean materials. Following remediation, the contaminated area would be restored.

Reduction of Toxicity, Mobility or Volume: This alternative would result in a significant reduction of toxicity, mobility, and volume through source removal and off-site disposal. If necessary, the materials would be treated at the off-site facility prior to disposal.

Short-Term Effectiveness: The potential public health threats to workers and area residents would include direct contact with contaminated soils and inhalation of fugitive dust generated during excavation and soil handling. The area would be secured and access would be restricted to authorized personnel only. Dust control measures such as wind screens and water sprays would be used, as necessary, to minimize fugitive dust emission resulting from excavation and soil handling. Air monitoring would be conducted throughout the site remediation activities.

The risk to workers would be minimized by the use of adequate preventive measures such as enclosed cabs on excavation equipment and proper PPE to prevent direct contact with contaminated soil and inhalation of fugitive dust. Short-term impacts on the environment resulting from removal of vegetation and destruction of habitat in the soil would be minimal since the plant area has minimal vegetation. Impacts would be temporary and would be mitigated by restoring the remediated area. Erosion control measures, such as silt fencing, would be provided during excavation activities to control migration of contaminated soil.

For this alternative, short-term impacts to the environment would be due to potential fugitive emissions during handling of excavated soil and increased traffic and noise, resulting from hauling soil and clean fill on-site. Wildlife displacement may occur during construction activities; however, this would be temporary and any displaced species would be expected to return after completion of site activities.

A total period of one to two years is estimated for this remedial alternative for planning, design, and procurement. Construction work associated with this alternative is expected to take two to three years.

Implementability:

Technical Feasibility

All the components of this remedial alternative are well developed and commercially available. There is some level of difficulty in the implementation of Alternative SL4. The first difficulty is locating an appropriate disposal facility for the excessive volumes of excavated soil. Also, there may be difficulty if the water table (i.e. groundwater) or river water is encountered during excavation of soils along the shorelines and throughout the RSC, as it may involve pumping water from excavations or dewatering soils from the deeper excavations. Due to site conditions in certain areas (e.g., Slag Disposal Area) it may be difficult to excavate the contaminated soil. Caution would need to be exercised as there are low hanging utility wires on-site. Also, excavation near and between buildings on-site may require the use of specialized equipment. Sufficient area is available at the site for staging wastes. There is some level of difficulty in the implementation of Alternative SL4. The first difficulty is locating an appropriate disposal facility for the excessive volumes of excavated soil. Also, there may be difficulty if the water table (i.e., groundwater) or river water is encountered during excavation of soils along the shorelines and throughout the RSC, as it may involve pumping water from excavations or dewatering soils from the deeper excavations. Excavation, off-site transportation, and restoration of the site can be performed with little difficulty.

Administrative Feasibility

Implementation of this alternative would require public access restriction to the site during the remediation process. Since contamination above ARARs would not remain on-site, a DER or other deed restriction would not be required upon completion of the remedial activities.

Availability of Services and Materials

Excavation and placement of fill materials utilize common construction equipment and should not pose any problems. However, some difficulty may be encountered due to the large volume of material and the size of the slag "boulders."

Cost: The total present worth for this alternative is estimated to be $649,931,000. Cost breakdowns are provided in Table 4-1. Data in support of these cost estimates are presented in Appendices B and C. The allocation of cost to the soil and Slag Disposal Area is presented in Table C-35 in Appendix C.

4.3 DETAILED EVALUATION OF REMEDIAL ALTERNATIVES FOR SEDIMENTS

This section presents a description and the results of the analysis of alternatives against the first seven evaluation criteria for each of the following alternatives:

Alternative SD1: No Action
Alternative SD2: Limited Action
Alternative SD3: Containment
Alternative SD4: Dredging/Dewatering/Off-Site Disposal
Alternative SD5: Dredging/Dewatering/On-Site Disposal

4.3.1 Alternative SD1: No Action

4.3.1.1 Description

This alternative includes no remedial activities at the RSC. All sediment contamination would remain and five-year reviews would be performed to assess the risk posed by the sediment contamination.

4.3.1.2 Evaluation

Overall Protection of Human Health and the Environment: The No Action alternative would not entail removal or other on-site containment or treatment of the contaminated sediments. Therefore, it would not provide adequate protection of human health and the environment since there would not be any immediate reduction in the toxicity, mobility or volume of the contaminants. Risks to ecological receptors would go unabated and impacts would continue to be expected in the aquatic habitats of the Back Channel and Crafts Creek. The potential for site access and exposure risks would continue.

Compliance with ARARs: The No Action alternative does not comply with ARARs. Since no attenuation of contamination is achieved, chemical-specific ARARs are not satisfied. Since no site closure or remediation is accomplished, RCRA is not satisfied (an action-specific ARAR).

Long-Term Effectiveness: The No Action alternative would not result in attainment of target cleanup levels. Future risk for ecological receptors may decrease as deposition of non-contaminated sediments continue to cover contaminated sediments. Ecological receptors at the site would continue to be impacted by contaminated media. This alternative would not restore any wetland areas.

Reduction of Toxicity, Mobility or Volume: This alternative would not involve any containment, removal, treatment or disposal of the contaminated sediments. Therefore, this alternative would not result in any immediate reduction in the toxicity, mobility or volume of contaminants. Over time, through sediment suspension and redeposition, contaminant concentrations may eventually decline.

Short-Term Effectiveness: No construction would be involved in this alternative. There would be no short-term threats to neighboring communities and no significant impacts on public health from the implementation activities. This alternative would not result in any short-term improvement over current conditions. Contaminants would persist at the site. As no design or construction are involved in this alternative, it would not take any time to implement.

Implementability

Technical Feasibility

No treatment is employed in this alternative. Remedial action can be easily undertaken. However, it may be necessary to go through the RI/FS/ROD process again.

Administrative Feasibility

Long-term institutional management would be associated with this alternative since contaminants would remain on site and review would be necessary every five years.

Availability of Services and Materials

This alternative does not involve any treatment, storage or disposal services.

Cost: There is no capital cost for the No Action alternative. The cost of five-year reviews for the site for a 30-year period has a present worth of $54,000 based on $25,000 per review and a seven percent discount rate. Cost breakdowns are provided in Table 4-2. Data in support of these cost estimates are presented in Appendices B and C.

4.3.2 Alternative SD2: Limited Action

4.3.2.1 Description

The Limited Action alternative for the sediments would consist of implementing restrictions on land use. Because this alternative does not include contaminant removal, the site would have to be reviewed every five years for a period of 30 years per requirements of CERCLA as amended. These five-year reviews would include the reassessment of human health and environmental risks due to the contaminated material left on site. Long-term monitoring would be provided.

4.3.2.2 Evaluation

Overall Protection of Human Health and the Environment: This alternative would not meet the RAOs for sediment. The contaminated materials would not be removed, contained or treated. Institutional controls would reduce the likelihood of human exposure to contaminated sediments, but could not guarantee that no exposures would occur. Risks to ecological receptors would go unabated and impacts, both measured and predicted, would continue to be expected in the aquatic habitats of the Back Channel and Crafts Creek.

TABLE 4-2 (Sheet 1 of 5)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
COMPARISON OF ALTERNATIVES FOR SEDIMENTS

Criteria	Alternative SD1 No Action	Alternative SD2 Limited Action	Alternative SD3 Containment	Alternative SD4 Dredging/Dewatering/ Off-Site Disposal	Alternative SD5 Dredging/Dewatering/ On-Site Disposal
Key Components	5-year reviews, site inspections, and agency coordination.	Long-term monitoring, 5-year reviews, institutional controls.	Partial excavation of sediments and capping. Wetlands would be restored.	Dredging, dewatering, transportation, off-site disposal, fill with clean sandy material and wetlands restoration.	Dredging, dewatering and on-site disposal. Clean fill placement and wetlands restoration.
1. Overall Protection of Health and the Environment	Provides no protection of human health since contaminants remain on-site. Does not protect the environment or restore wetlands.	Provides little protection of human health since contaminants remain on-site and institutional controls may be ineffective. Does not protect the environment or restore wetlands.	Provides overall protection of human health and the environment by eliminating contaminant exposure routes for human and ecological receptors and by restoring ecologically sensitive areas (i.e., wetlands).	Reduction in toxicity, mobility and volume of contaminants on site. Excavation would disturb vegetation and wildlife. Would result in restoration of all wetlands.	Reduce risks to the environment associated with migration of contaminated sediments. Excavation would disturb vegetation and wildlife. Would result in restoration of all wetlands.
2. Compliance with ARARs/TBCs					
• Chemical-Specific ARARs/TBCs	Does not comply.	Does not comply.	Would not comply with chemical-specific ARARs/TBCs, since contaminants are not removed to cleanup levels.	Would comply with all chemical-specific ARARs/TBCs.	Chemical-specific ARARs/TBCs are achieved for sediment areas by removing sediments from those areas.
• Action-Specific ARARs	Not applicable.	Would comply as applicable.	Would be performed in accordance with action-specific ARARs.	Would be performed in accordance with action-specific ARARs.	Would be performed in accordance with action-specific ARARs.
• Location-Specific ARARs	Not applicable.	Would comply as applicable.	Would be performed in accordance with location-specific ARARs. Waivers may be required for actions near wetlands.	Would be performed in accordance with location-specific ARARs. Waivers may be required for action near wetlands.	Would be performed in accordance with location-specific ARARs. Waivers may be required for action near wetlands.
• Compliance with criteria, advisories and guidances	Not applicable.	Not applicable.	Would be in compliance with federal, state and local criteria, advisories and guidance.	Would be in compliance with federal, state and local criteria, advisories and guidance.	Would be in compliance with federal, state and local criteria, advisories and guidances.
3. Long-Term Effectiveness					
• Magnitude of residual risks	Source has not been removed. Existing risk would remain. Eventually natural processes may decrease risk.	Source has not been removed. Existing risk would remain. Eventually natural processes may decrease risk.	Would mitigate human health and ecological risks. However, the contamination would remain on-site.	Dredging, dewatering, and removal from the site would result in a permanent remedy.	Contamination remains on-site; however, contaminant levels in sediment disposed on-site would not pose an unacceptable human health or ecological risk.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
COMPARISON OF ALTERNATIVES FOR SEDIMENTS

Criteria	Alternative SD1 No Action	Alternative SD2 Limited Action	Alternative SD3 Containment	Alternative SD4 Dredging/Dewatering/ Off-Site Disposal	Alternative SD5 Dredging/Dewatering/ On-Site Disposal
3. Long-Term Effectiveness (Cont'd)					
• Adequacy of controls	Requires 5-year reviews.	Institutional controls provide more protection than no action, but no guarantee against exposure.	Exposure to contaminated sediment reduced. However, contaminants remain on-site. Long-term monitoring would be required.	Exposure to contaminated sediments is eliminated.	Exposure to contaminated sediment eliminated. However, contaminants remain on-site.
• Reliability of Control	Existing fence and monitoring wells are susceptible to vandalism; existing fence does not enclose all contaminated areas. These measures are not fully protective.	Existing fence and monitoring wells are susceptible to vandalism; existing fence does not enclose entire contaminated area. Institutional controls may be violated.	Caps must be maintained on a regular basis.	Dredging and disposal are reliable.	Dredging and disposal are reliable.
4. Reduction of Toxicity, Mobility and Volume					
• Treatment process and remedy	No treatment employed.	No treatment employed.	Containment of sediments with cap.	Disposal of contaminated sediments at controlled off-site disposal facility.	Dredging and on-site disposal.
• Amount of hazardous material destroyed or treated	None by treatment. Natural processes continue to take place resulting in decreased levels of contamination; however, this would take an extremely long time.	None by treatment. Natural processes continue to take place resulting in decreased levels of contamination; however, this would take an extremely long time.	Cap over 87,000 square yards of sediments.	116,000 cy of sediment to be disposed of off-site.	116,000 cy of sediments to be disposed of on-site.
• Reduction of toxicity, mobility and volume	None by treatment. Natural migration might increase volume of contaminated sediment. No change in mobility.	None by treatment. Natural migration might increase volume of contaminated sediment. No change in mobility.	Does not reduce toxicity, or volume. Mobility may be decreased if caps are properly maintained.	Contaminated sediments are removed from the site. Would achieve reduction of toxicity, mobility and volume.	Mobility of contaminants is significantly reduced. Contamination remains on-site.
• Type and quantity of treatment residues	No treatment involved.	No treatment involved.	No treatment residues are generated on-site.	No treatment residues are generated on-site.	Contaminated sediments remain on-site for disposal.

TABLE 4-2 (Sheet 3 of 5)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
COMPARISON OF ALTERNATIVES FOR SEDIMENTS

Criteria	Alternative SD1 No Action	Alternative SD2 Limited Action	Alternative SD3 Containment	Alternative SD4 Dredging/Dewatering/ Off-Site Disposal	Alternative SD5 Dredging/Dewatering/ On-Site Disposal
5. <u>Short-Term Effectiveness</u>					
• Protection of community during remedial actions	There are no remedial actions. Risk to community not increased. No protection required.	There are no remedial actions. Risk to community not increased. No protection required.	Some odor and minimal fugitive emissions due to wet state of sediments.	Some odor and minimal fugitive emissions due to wet state of sediments. Traffic control required.	Some odor and minimal fugitive emissions due to wet state of sediments.
• Protection of workers during remedial actions	No significant risk.	Protection required against dermal contact, inhalation and ingestion of contaminated sediment.	Protection required against dermal contact, inhalation and ingestion of contaminated sediment.	Protection required against dermal contact, inhalation and ingestion of contaminated sediments.	Protection required against dermal contact, inhalation and ingestion of contaminated sediments.
• Environmental impacts	Continued impact from existing conditions. Wildlife continues to be impacted.	Continued impact from existing conditions. Wildlife continues to be impacted.	Clearing of vegetation required. May impact wetland habitats.	Clearing of vegetation required. May impact wetland habitats.	Clearing of vegetation required. May impact wetland habitats.
• Time until remedial response objectives are achieved	Natural processes would take a long period of time.	Natural processes would take a long period of time.	Planning, design, and procurement estimated to be one year. Subsequent capping and wetland restoration period estimated to be one year.	Planning, design, and procurement estimated to be one year. Subsequent remediation period is estimated to be one to two years.	Planning, design, and procurement estimated to be one year. Subsequent remediation period is estimated to be one to two years.
6. <u>Implementability</u>					
<u>Technical Feasibility</u>					
• Ability to construct and operate technology	No major construction involved.	No major construction involved. Institutional controls are easy to implement.	Containment is technically implementable.	Dredging and transportation are technically implementable.	Dredging and transportation are technically implementable.
• Reliability of Technology	No treatment technology involved.	No treatment technology involved. Monitoring is reliable.	Containment is a reliable technology.	Dredging and disposal are reliable.	Dredging and disposal are reliable.
• Ease of undertaking additional remedial action, if necessary	If review indicates that more action is necessary, may need to go through the RI/FS/ROD process again.	If monitoring and/or review indicates that more action is necessary, may need to go through the RI/FS/ROD process again.	Containment materials can be added and maintained if necessary. Contaminant would need to be disturbed to facilitate other remedial actions.	Additional sediment would be dredged and transported if required to do so or implement other remedial actions.	Additional sediment can be excavated and disposed of if necessary or implement other remedial actions.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
COMPARISON OF ALTERNATIVES FOR SEDIMENTS

Criteria	Alternative SD1 No Action	Alternative SD2 Limited Action	Alternative SD3 Containment	Alternative SD4 Dredging/Dewatering/ Off-Site Disposal	Alternative SD5 Dredging/Dewatering/ On-Site Disposal
Implementability (Cont'd)					
• Monitoring Considerations	None provided.	Long-term monitoring would be required. Migration or exposure pathways can be monitored.	Long-term monitoring would be required since contained sediment would remain in place. Migration or exposure pathways can be easily monitored.	A period of long-term monitoring (e.g., 3 to 5 years) would be implemented.	A period of long-term monitoring (e.g., 3 to 5 years) would be implemented.
Administrative Feasibility					
• Coordination with other agencies	Coordination required with local agencies for monitoring and reviewing the site conditions.	Coordination required with local agencies for monitoring and reviewing the site. Additional coordination needed for institutional controls.	Coordination with local agencies required for monitoring and site reviews.	Coordination with local agencies and DOT required for transportation of contaminated sediment for off-site disposal.	Coordination with soil remedy implementation is required to place dredged sediments on-site.
Availability of Services and Materials					
• Availability of treatment, storage capacity, and disposal services	No treatment, storage or disposal facilities required.	No treatment, storage or disposal facilities required.	No treatment, storage or disposal facilities required.	Off-site disposal facilities are available.	On-site staging areas are available. On-site disposal areas are available.
• Availability of necessary equipment, specialists and materials	None required.	Equipment and specialists for monitoring are readily available locally.	Containment services and equipment are available.	Local services and equipment are available for dredging and transportation. Specialists for wetland restoration are available.	Local services and equipment are available for dredging and transportation. Specialists for wetland restoration are available.
• Availability of technologies	None required.	None required.	Several alternatives are available for containment.	Alternatives are available for dredging and off-site disposal.	Alternatives are available for dredging and on-site disposal.

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TABLE 4-2 (Sheet 5of 5)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
COMPARISON OF ALTERNATIVES FOR SEDIMENTS

Criteria	Alternative SD1 No Action	Alternative SD2 Limited Action	Alternative SD3 Containment	Alternative SD4 Dredging/Dewatering/ Off-Site Disposal	Alternative SD5 Dredging/Dewatering/ On-Site Disposal
7. Costs					
• Total Capital Cost ($)	$0	$21,000	$4,218,000	$19,279,000	$11,354,000
• Annual operation and maintenance cost ($/yr)*	$0	$47,000	$62,000	$0	$0
• Present worth of operation and maintenance cost ($)**	$54,000	$635,000	$926,000	$0	$0
• Present worth ($ based on 7 percent discount rate and 30 year period)	$54,000	$656,000	$5,144,000	$19,279,000	$11,354,000

*Annual O&M excludes 5-year reviews and one-time contingency in year 3.
**Present worth of O&M includes 5-year reviews and one-time contingency in year 3.

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Compliance with ARARs: This alternative does not eliminate the source of contamination. It does not satisfy any of the identified chemical-specific ARARs/TBCs. Location- and action-specific ARARs would be followed where possible, and waivers would need to be obtained as necessary.

Long-Term Effectiveness: The Limited Action alternative would not achieve any of the RAOs. The Limited Action alternative would slowly reduce the level of contamination from the source area by migration and deposition of non-contaminated sediments over contaminated areas.

The implementation of this alternative would not have any beneficial effects on the environment. Potential long-term adverse environmental impacts do exist because the contaminated sediments would remain on site. The potential for contaminant migration still remains. Public education programs and land use restrictions would minimize exposure risk to the community.

Reduction of Toxicity, Mobility or Volume: This alternative does not involve any containment, removal, treatment or disposal actions for contaminated sediments. In addition, the mobility of the contaminants would remain unchanged. Over time, through natural processes, contaminant concentrations would eventually decline. However, the time needed to reach acceptable risk levels is unknown.

Short-Term Effectiveness: No major construction would be involved in this remedial alternative. Therefore, there are no additional short-term threats to neighboring communities and no significant impacts on public health and the environment from the implementation activities. The potential exists for site assessment personnel to contact contaminated sediments during sampling. Institutional programs could be instituted in approximately six months to one year.

Implementability:

Technical Feasibility

Land use restrictions and the long-term monitoring program could be easily implemented.

Administrative Feasibility

Considerable long-term institutional management would be associated with this alternative for maintenance of institutional controls, and the five-year reviews.

Availability of Services and Materials

The monitoring equipment and analytical laboratories are commercially available and proven. Services and materials required for site monitoring and sampling are readily available in the area. Numerous vendors would be available for competitive bids.

Cost: The total present worth, calculated based on a discount rate of seven percent and a 30-year period is $656,000. Cost breakdowns are provided in Table 4-2. Data in support of these cost estimates are presented in Appendices B and C.

4.3.3 Alternative SD3: Containment

4.3.3.1 Description

This alternative consists of containment of contaminated sediments by capping. Soil caps would be used in the sediment areas to contain contaminants and eliminate the exposure routes of concern. In order to prevent disruption of water flow patterns, capping of sediments would also involve removing the top 1.5 feet of sediments (i.e. same amount as cap) before placing the soil cap of the same thickness. Alternative SD3 also includes long-term monitoring and long-term maintenance, since contaminants remain in the sediment. Wetland restoration would also be performed, if the initial restoration is not satisfactory.

4.3.3.2 Evaluation

Overall Protection of Human Health and the Environment: Containment of contaminated sediments provides overall protection of human health and the environment by eliminating the contaminant exposure pathways for human and ecological receptors, and by restoring the ecologically sensitive areas. Risks to ecological receptors would be abated through an interruption of the exposure pathway between contaminated sediments and ecological receptors. A confining layer between the bioturbation zone and contaminated media would be the primary measure to interrupt this exposure pathway. Removal and replacement of sediment would result in the disturbance of the existing benthic community and temporary disturbance of wildlife. The benthic community is expected to recover following completion of the construction phase through invertebrate drift and recolonization of the sediment cap. Wildlife utilization of the areas affected by remediation would be expected to recover following completion of construction activities and restoration of remediated habitats. The protection would persist only as long as the containment measures were actively maintained, since contaminants would remain and a breach of containment measures could re-establish human and/or ecological exposure routes.

Compliance with ARARs: All activities for this alternative would be performed in accordance with location and action-specific ARARs to the maximum extent possible. For example, Executive Order 11990 and the New Jersey Wetlands Act would be addressed for dredging activities in Crafts Creek and the Back Channel. Substantive requirements of State and Federal wetland permits would be submitted to the appropriate agencies to ensure that the alternative complies with wetland regulations. In addition, a consistency review of this alternative with coastal zone regulations would be required. The Endangered Species Act and Fish and Wildlife Coordination Act would impact dredging activities since these activities would change existing habitats prior to creating new habitats. Efforts would be made to preserve or record any historic artifacts in accordance with the Archaeologic Resources Protection Act. Substantive requirements of relevant and appropriate federal and state waste management regulations regarding capping of wastes would be met. Waivers would be sought, if necessary, based on technical impracticality of complying with certain ARARs.

Long-Term Effectiveness: Capping of contaminated sediment would eliminate the human health and ecological exposure risks as long as the capped areas were maintained and future activities did not disrupt the capped areas, thereby re-establishing exposure routes. Since the contamination is left in place, the potential exists for migration of contaminants into surface water and the establishment of new exposure routes. Erosion and bioturbation may reduce the long-term performance of a cap. In wetland areas, vegetation would be used to reduce these effects. Long-term monitoring would be required for this alternative.

Reduction of Toxicity, Mobility or Volume: This alternative would not result in any reduction of toxicity or volume through treatment. Due to the soil cover, there would likely be a reduction in mobility of contaminants via infiltration and/or erosion, but only if these caps are maintained.

Short-Term Effectiveness: During implementation of this alternative, workers could potentially be exposed to contaminants in the sediments. This risk would be minimized by use of appropriate PPE to prevent contact and inhalation. There is also the potential for nearby populations to be exposed to contaminated material. The RSC would be secured during construction activities to prevent unauthorized access. Some contaminated sediments would be dredged prior to cap placement; however, fugitive dust should not be a problem, since these materials would be wet.

Environmental impacts during implementation of this alternative would include: increased traffic and noise resulting from importing cover material from an off-site source and movement of dredged sediments for disposal; destruction of wetlands; and disturbance of other vegetated areas. The wetlands would be re-established as part of this remedial alternative. Activities would be scheduled to minimize ecological impacts (e.g., wetlands would be disturbed only when revegetation is possible). Ecological impacts of dredging would also include the disturbance of the existing benthic habitat. This short-term impact would be reversed as the benthic habitat replenishes itself. Additionally, the dredging may mobilize subsurface contaminated material and cause it to come into contact with ecological receptors. Construction activities would be performed so as to minimize the impacted area. Disturbance of wetland areas would be minimized to the extent possible, and protection would be provided when work must occur in these areas. Also, the site would be restored upon completion of the remedial construction.

Planning, design, and procurement of resources for this alternative would take approximately one year. Construction work associated with the containment alternative is estimated to take one year.

Implementability:

Technical Feasibility

All the components of this alternative are well developed and commercially available and capping is an easily implemented technology. Long-term monitoring and maintenance would also be required.

Administrative Feasibility

Implementation of this alternative would require continued restrictions on site access during construction.

In order to perform the required construction activities in Crafts Creek, it would be necessary to establish access facilities for heavy equipment, dredge spoils and backfill. It would likely be necessary to attain access agreements with one or more property owners to construct and use these facilities.

Availability of Services and Materials

Construction services for dredging and cap construction are readily available as these represent conventional construction activities. Materials for capping are also available, but careful planning and coordination would be required to ensure that adequate quantities of material were available and transported to the site for efficient implementation of this alternative.

Cost: The total present worth, calculated based on a discount rate of seven percent and a 30-year period is $5,144,000. Cost breakdowns are provided in Table 4-2. Data in support of these cost estimates are presented in Appendices B and C.

4.3.4 Alternative SD4: Dredging/Dewatering/Off-Site Disposal

4.3.4.1 Description

This alternative consists of dredging the contaminated sediments, dewatering and off-site disposal. This alternative also includes a period of long-term monitoring (e.g., 3 to 5 years) and additional wetland restoration if the initial restoration is not satisfactory. No long-term O&M would be associated with this alternative, since all of the contaminants are removed.

4.3.4.2 Evaluation

Overall Protection of Human Health and the Environment: The dredging and removal of contaminated sediments from the site would eliminate the potential human health and ecological risks associated with exposure to contaminated sediments. Risks to ecological receptors would be abated through an elimination of the exposure pathway between contaminated sediments and ecological receptors. Contaminated sediments would be excavated and disposed of off-site. The sediments would be treated (e.g., stabilized) if necessary, to meet disposal requirements (e.g., LDRs). Excavated areas would be backfilled with appropriate clean fill. Excavation of the sediments would result in the destruction of the existing benthic community and temporary disturbance of wildlife during the construction phase of the remediation. The benthic community is expected to recover following completion of the construction phase through invertebrate drift and recolonization of newly applied fill material. Wildlife utilization would be expected to increase with the completion of construction activities and restoration of remediated habitats. This alternative would restore the contaminated sediment area to its natural wetland state and would result in overall protection of human health and the environment.

Compliance with ARARs: This alternative would comply with ARARs and TBCs. Compliance with chemical-specific TBCs would be achieved by excavation of contaminated sediments, dewatering and transportation off-site for disposal. Location-specific ARARs would be addressed as discussed for Alternative SD3.

Long-Term Effectiveness: The dredging and removal of contaminated sediments from the RSC would eliminate the potential ecological risks associated with contaminated sediments. Excavated sediments would be replaced by clean materials. Following remediation, the contaminated area would be restored.

Reduction of Toxicity, Mobility or Volume: Dredging, dewatering and off-site disposal constitute a treatment that would result in a permanent remedy. Contaminants in the sediments would be treated, if necessary, to meet disposal requirements, and disposed of in a controlled off-site landfill. Therefore, this alternative would completely eliminate the toxicity, mobility and volume of contaminants at the site by removing nearly all of them.

Short-Term Effectiveness: The potential public health threats to workers and area residents would include direct contact with contaminated sediments. There is also the potential for nearby populations to be exposed to contaminated material. The area would be secured and access would be restricted to authorized personnel only.

The risk to workers would be minimized by the use of adequate preventive measures such as proper PPE to prevent direct contact with contaminated sediment. Short-term impacts on the environment would result from the removal of vegetation and destruction of habitats in the sediment areas. Impacts would be temporary and would be mitigated by restoring the remediated area. Activities would be scheduled to minimize ecological impacts (e.g., wetlands would be disturbed only when revegetation is possible). Ecological impacts of dredging would also include the disturbance of the existing benthic habitat. This short-term impact would be reversed as the benthic habitat replenishes itself. Additionally, the dredging may mobilize subsurface contaminated material and cause it to come into contact with ecological receptors. Construction activities would be performed so as to minimize the impacted area. Disturbance of wetland areas would be minimized to the extent possible, and protection would be provided when work must occur in these areas. Also, the site would be restored upon completion of the remedial construction. Erosion and sediment control measures such as silt fencing would be provided during dredging activities to control migration of contaminated sediment.

Additional short-term environmental impacts would be due to increased traffic and noise resulting from hauling sediment off-site and clean fill on-site. Transportation of excavated sediment may introduce short-term risks with the possibility of spillage along the transport route. A traffic control plan developed with the assistance of local authorities would be implemented to minimize potential traffic problems.

Approximately 116,000 cy of sediments would be excavated from wetlands along the perimeter of the site within Crafts Creek and the Back Channel of the Delaware River. A total period of one year is estimated for this remedial alternative for planning, design, and procurement. The actual remediation period is estimated to be one to two years.

Implementability

Technical Feasibility

All the components of this remedial alternative are well developed and commercially available. The contaminated sediments would have to undergo a series of analyses prior to acceptance for disposal at the off-site facility. If necessary, treatment (e.g., stabilization) would be performed prior to disposal. Sufficient area is available at the RSC for staging. Dredging and transportation to an off-site disposal facility and restoration of the RSC can be performed with little difficulty.

Administrative Feasibility

Implementation of this alternative would require public access restriction to the site during the remediation process. Contractual procurement of off-site disposal facilities to handle the type and volume of sediment on site would be required. Coordination with state and local agencies would also be required. The transportation of wastes to an off-site facility would require appropriate permits and coordination with the Department of Transportation (DOT) and local traffic department. Traffic control plans would be required before remediation. The off-site disposal facilities would have to be in compliance with appropriate permit conditions such as RCRA and approved for use by USEPA Region 2.

In order to perform the required construction activities in Crafts Creek, it would be necessary to establish access facilities for heavy equipment, dredge spoils, and backfill. It would likely be necessary to attain access agreements with one or more property owners to construct and utilize these facilities.

Availability of Services and Materials

There are a number of disposal facilities that would accept the dredged sediments. Dredging and transportation utilize common construction equipment and should not pose any problems. Specialists for restoring wetlands in the remediated area are available.

Cost: The total present worth for this alternative is estimated to be $19,279,000. Cost breakdowns are provided in Table 4-2. Data in support of these cost estimates are presented in Appendices B and C.

4.3.5 Alternative SD5: Dredging/Dewatering/On-Site Disposal

4.3.5.1 Description

This alternative is similar to Alternative SD4 in that it includes dredging of contaminated sediments. The main difference is that unlike Alternative SD4 which calls for off-site disposal, Alternative SD5 includes on-site disposal of the dewatered material. The dredged sediment would be tested to ensure that the cleanup levels have been met and that it meets applicable requirements for on-site disposal. Sediments would only be disposed on-site if they are below soil cleanup criteria (i.e., RDCSCC). Dredged areas would be restored to original conditions by placement of clean material suitable for re-establishment of wetlands and/or benthic communities. This alternative also includes a period of long-term monitoring (e.g., 3 to 5 years) and additional wetland restoration if the initial restoration is not satisfactory. No long-term O&M would be associated with this alternative, since all of the contaminants are removed.

4.3.5.2 Evaluation

Overall Protection of Human Health and Environment: Removal of contaminated sediments would reduce the public health and ecological risks associated with direct contact. Risks to ecological receptors would be abated through an elimination of the exposure pathway between contaminated sediments and ecological receptors. Contaminated sediments would be excavated and disposed at an on-site location. Excavated areas would be backfilled with appropriate clean fill. Excavation of the sediments would result in the destruction of the existing benthic community and temporary disturbance of wildlife during the construction phase of the remediation. The benthic community is expected to recover following completion of the construction phase through invertebrate drift and recolonization of newly applied fill material. Wildlife utilization would be expected to increase with the completion of construction activities and restoration of remediated habitats. Disposal of excavated sediments would require proper containment to prevent exposure of terrestrial receptors to contaminated media. This alternative would result in overall protection of human health and the environment.

Compliance with ARARs: All remedial and monitoring activities would be conducted in accordance with chemical-specific ARARs/TBCs and location- and action-specific ARARs, as discussed for Alternatives SD3 and SD4. Due to the proximity of surface water bodies and wetlands to the site, waivers for some location-specific ARARs may be needed to conduct remedial activities in these areas.

Long-Term Effectiveness: Dredging and removal of contaminated sediments would reduce the risk caused by elevated contaminant levels because the sediments would be disposed and covered on-site. Cleanup requirements for sediments to mitigate risks to the environment, are much more stringent than cleanup for soil. It is possible to remove the contaminated sediment to meet cleanup criteria and place it on-site for disposal, since the contaminant levels in the sediment may be below the soil cleanup criteria.

Long-term effects to the wetland areas are not anticipated. Wetland areas impacted would be restored to original grade and revegetated upon completion of remedial activities.

Reduction of Toxicity, Mobility or Volume: Removal of the sediments would reduce the mobility of contaminants; the toxicity and volume would be unaffected by removal. The sediments would be disposed on-site if they were found to be below RDCSCC; otherwise, sediments would be disposed off-site.

Short-Term Effectiveness: The potential public health threats to workers and area residents would include direct contact with contaminated sediments. The area would be secured and access would be restricted to authorized personnel only.

The risk to workers would be minimized by the use of adequate preventive measures including proper PPE to prevent direct contact with contaminated sediment. Short-term impacts on the environment would result from the removal of vegetation and destruction of habitats in the sediment areas. Impacts would be mitigated by restoring the remediated area. Ecological impacts of dredging would also include the disturbance of the existing benthic habitat. This short-term impact would be reversed as the benthic habitat replenishes itself. Additionally, the dredging may mobilize subsurface contaminated material and cause it to come into contact with ecological receptors. Construction activities would be performed so as to minimize the impacted area. Disturbance of wetland areas would be minimized to the extent possible, and protection would be provided when work must occur in these areas. Also, the site would be restored upon completion of the remedial construction. Erosion and sediment control measures such as silt fencing would be provided during dredging and on-site placement activities to control migration of contaminated sediment.

Approximately 116,000 cy of sediments would be excavated from wetlands along the perimeter of the site within Crafts Creek and the Back Channel of the Delaware River. Additional areas may be cleared for laydown and storage. However, to the extent possible, these areas would be located outside of the wetlands, thereby minimizing impacts.

Displacement of wildlife, due to habitat alteration, traffic, and noise, would be short-term. Off-site traffic and noise would be significantly less than in Alternative SD4 as contaminated material would not leave the site. Traffic and noise would only be from bringing in clean fill materials. Activities would be scheduled to minimize ecological impacts (e.g., wetlands would be disturbed only when revegetation is possible). Revegetation of impacted areas and completion of remedial activities would alleviate situations causing wildlife displacement, and allow for reestablishment of wildlife populations.

A total period of one year is estimated for this remedial alternative for planning, design, and procurement. The subsequent actual remediation period is estimated to be one to two years.

<u>Implementability</u>

Technical Feasibility

All the components of this alternative are well developed and commercially available for implementation at the RSC. Sufficient land is available at the RSC for staging and disposal. Coordination with soil remedy implementation is required to place dredged sediment on-site.

Administrative Feasibility

Implementation of this alternative would require restriction of site access during the remediation process. Although no permits would need to be obtained for on-site remediation, the substantive requirements for the permits would have to be satisfied. Long-term monitoring would require regulatory attention.

In order to perform the required construction activities in Crafts Creek, it would be necessary to establish access facilities for heavy equipment, dredge spoils and backfill. It would likely be necessary to attain access agreements with one or more property owners to construct and utilize these facilities.

Availability of Services and Materials

Adequate space is available for on-site staging. Dredging and dewatering utilize common construction equipment and should pose no problems. Specialists for restoring wetlands in remediated areas are available.

Cost: The total present worth for this alternative is estimated to be $11,354,000. Cost breakdowns are provided in Table 4-2. Data in support of these cost estimates are presented in Appendices B and C.

4.4 DETAILED EVALUATION OF REMEDIAL ALTERNATIVES FOR GROUNDWATER

This section presents a description and the results of the analysis of alternatives against the first seven evaluation criteria for each of the following groundwater alternatives. Since Alternative GW3 was not retained for detailed evaluation based on the screening in Section 3.5.3.3, the succession of groundwater alternatives is GW1, GW2, and GW4, as presented below:

Alternative GW1: No Action
Alternative GW2: Limited Action
Alternative GW4: Restoration (Extraction Wells for Pump-and-Treat)
- Option (a): with source removal
- Option (b): without source removal

4.4.1 Alternative GW1: No Action

4.4.1.1 Description

This alternative includes no remedial activities at the RSC. All groundwater contamination would remain and five-year reviews would be performed to assess the risk posed by the RSC.

4.4.1.2 Evaluation

Overall Protection of Human Health and the Environment: The No Action alternative would not entail any on-site containment or treatment of the contaminated groundwater. Thus, it would not provide adequate protection of human health and the environment since there would not be any immediate reduction in the toxicity, mobility, or volume of the contaminants. The risk of exposure to contaminated groundwater and associated ecological risks would not be controlled. In addition, the potential for site access and exposure risks would continue.

Compliance With ARARs: Alternative GW1 does not comply with ARARs. Chemical-specific ARARs are not satisfied since contaminant attenuation is not achieved. Similarly, RCRA (an action-specific ARAR) is not satisfied because no site closure or remediation is accomplished.

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Long-Term Effectiveness: The No Action alternative does not result in the attainment of target cleanup levels. Based on comprehensive contaminant modeling (see Appendix D), it is estimated that approximately 90,000 years would be required before natural attenuation and transport mechanisms significantly reduce the toxicity and concentration of contaminants in the groundwater. Natural attenuation typically includes dilution, dispersion, and biodegradation of constituents over time; however, biodegradation would not contribute to natural attenuation at the site because many of the contaminants of concern are inorganics.

This alternative does not reduce human health risks; however, there are no known groundwater users that would be exposed to the contaminants. Ecological receptors at the site would continue to be impacted by contaminated groundwater. There is also the potential for groundwater to have adverse impacts on surface water.

Reduction of Toxicity, Mobility or Volume: Alternative GW1 would not involve any containment, removal, treatment or disposal of the contaminated groundwater. Therefore, this alternative would not result in any immediate reduction in the toxicity, mobility or volume of contaminants.

Short-Term Effectiveness: No construction would be involved in the No Action alternative. There would be no short-term threats to neighboring communities and no significant impacts on public health from the implementation activities. This alternative would not result in any short-term improvement over current conditions and contamination would persist at the site. As no design nor construction is involved in this alternative, it would not take any time to implement.

Implementability:

Technical Feasibility

No treatment is employed in this alternative. Remedial action can be easily undertaken. However, it may be necessary to go through the RI/FS/ROD process again.

Administrative Feasibility

Long-term institutional management would be associated with this alternative since contaminants would remain on site and review would be necessary every five years.

Availability of Services and Materials

This alternative does not involve any treatment, storage, or disposal services.

Cost: There is no capital cost for the No Action alternative. The cost of five-year reviews for the site for a 30-year period has a present worth of $54,000 based on $25,000 per review and a seven percent discount rate. Cost breakdowns are provided in Table 4-3. Data in support of these cost estimates are presented in Appendices B and C.

4.4.2 Alternative GW2: Limited Action

4.4.2.1 Description

The Limited Action alternative for groundwater would include implementing use restrictions and establishment of a CEA.

Because this alternative does not include contaminant removal, the site would have to be reviewed every five years for a period of 30 years per requirements of CERCLA as amended. These five-year reviews would include the reassessment of human health and environmental risks due to the contaminated material left on site. Long-term monitoring would also be necessary. The long-term monitoring program would be performed in accordance with a Long-Term Monitoring Plan, which would be developed in accordance with the Final OSWER Monitored Natural Attenuation Policy, following adequate delineation of the groundwater plume.

4.4.2.2 Evaluation

Overall Protection of Human Health and the Environment: Alternative GW2 would not meet the RAOs for groundwater. The contamination would not be removed, contained or treated. However, limited action would reduce the likelihood of exposure to contaminated groundwater, but could not guarantee that no exposures would occur.

Compliance with ARARs: This alternative does not eliminate the source of contamination. It does not satisfy any of the identified chemical-specific ARARs. Location- and action-specific ARARs would be followed or waivers would be obtained as necessary.

Long-Term Effectiveness: The Limited Action alternative would not have any beneficial effects on the environment. Potential long-term adverse environmental impacts do exist because the contaminated groundwater would remain on site. The potential for contaminant migration still remains. Public education programs and groundwater use restrictions would minimize exposure risk to the community.

Reduction of Toxicity, Mobility or Volume: This alternative does not involve any containment, removal, treatment or disposal actions for contaminated groundwater. In addition, the mobility of the contaminants would remain unchanged; therefore, the potential for contaminant migration still exists. Natural attenuation typically includes dilution, dispersion, and biodegradation of constituents over time; however, biodegradation would not contribute to natural attenuation site because of the inorganic contaminant levels at this site. Based on the comprehensive contaminant modeling, the time needed for natural attenuation to occur is approximately 90,000 years.

Short-Term Effectiveness: Alternative GW2 would not achieve any of the RAOs for groundwater. No major construction would be involved in this remedial alternative. Therefore, there are no short-term threats to neighboring communities and no significant impacts on public health and the environment from the implementation activities. A potential exists for site assessment personnel to contact contaminated groundwater during sampling events. Institutional programs could be instituted in approximately six months to one year.

Implementability

Technical Feasibility

The CEA and well restrictions could be easily implemented. Any additional institutional control measures can be easily accomplished. Additional remedial action can be easily undertaken. However, it may be necessary to go through the RI/FS/ROD process again.

Administrative Feasibility

Considerable long-term institutional management would be associated with this alternative for maintenance of institutional controls and the five-year reviews. NJDEP requirements for a CEA would have to be met.

Availability of Services and Materials

Monitoring equipment and analytical laboratories are commercially available and proven. Services and materials required for site monitoring and sampling are readily available in the area. Numerous vendors would be available for competitive bids.

Cost: The total present worth, calculated based on a discount rate of seven percent and a 30-year period is $686,000. Cost breakdowns are provided in Table 4-3. Data in support of these cost estimates are presented in Appendices B and C.

4.4.3 Alternative GW4: Restoration (Extraction Wells for Pump-and-Treat)

4.4.3.1 Description

This alternative includes groundwater restoration via extraction wells for a pump-and-treat system. The groundwater treatment system would include several process options, such as equalization, precipitation, filtration, adsorption, neutralization, discharge, and sludge handling, for the removal of certain contaminants. There are also two options associated with Alternative GW4: Option (a) which includes source removal and Option (b) which does not include source removal. Source removal consists of excavating all of the impacted soils from the main plant area (OU-5) and all of the material in the Slag Disposal Area (OU-3) as described in Section 3.2.4, Alternative SL4. This alternative also includes the establishment of a CEA to restrict the use of groundwater, since it would take a long time until ARARs are achieved. The long-term monitoring program would be performed in accordance with a Long-Term Monitoring Plan, which would be developed in accordance with the Final OSWER Monitored Natural Attenuation Policy, following adequate delineation of the groundwater plume.

4.4.3.2 Evaluation

Overall Protection of Human Health and the Environment: Since exposure to contaminants and adverse impacts attributable to the contaminated media are minimized, protection of human health and the environment is achievable. By implementing a restoration system, the groundwater contaminants would be removed via a series of unit operations and treated groundwater can either be discharged into a nearby surface water body, (i.e., the Delaware River) or to the local POTW.

Thus, exposure pathways are controlled and further adverse impacts to the environment are mitigated. Based on modeling results, the time to achieve protection would be 35,000 years.

Overall protection of human health and the environment due to impacted soil would also be greater if Option (a) were utilized, since these contaminated source areas would be excavated and removed from the site. If using Option (b) in conjunction with Alternative GW4, the environment would not be as protected since the sources would not be removed; therefore, further adverse impacts to groundwater could occur.

Compliance with ARARs: Alternative GW4 could potentially achieve the chemical-specific ARARs over an extended period of time, since the treatment technologies would reduce contaminant concentrations to the required cleanup levels. Likewise, the treated groundwater would meet the discharge limits to surface water, as established by NJDEP. Location-specific ARARs would be achieved since the remedial measures take into account the potential adverse affects to wetlands, ecological habitats, the Crafts Creek sediments, and the Delaware River sediments. This alternative also achieves the action-specific ARARs regarding hazardous waste management, discharge of treated waters, and disposal measures.

This alternative would also comply with RCRA and related state regulations applicable to be technologies being utilized. By utilizing Option (a), the chemical-specific, location-specific, and action-specific ARARs for soil are also achieved due to the removal of source areas. However, by utilizing Option (b), chemical-specific ARARs would not be fully achieved, since the source areas remain on site.

The TI Evaluation (Appendix E) for OU-5 is provided for the additional clarification of the TI aspects of the groundwater restoration alternative. Due to the extremely long timeframe of remediation, the difficulty in extracting certain contaminants from the aquifer, and the large spatial area of site-wide contamination, present worth cost is also considered as a factor. Present worth cost is taken into account because of the inability to achieve groundwater ARARs or target cleanup levels in a reasonable timeframe and the inordinate cost of complying with those ARARs.

Long-Term Effectiveness: This alternative provides a permanent remedy for the site, since the groundwater contaminants are removed and treated in an on-site treatment system. With routine monitoring and maintenance, on-site remedies can perform according to design requirements for many years. The technologies used in the treatment system are proven and used routinely as reliable measures to control contaminated groundwater. In addition to on-site remedies, off-site remedies are also employed, such as permitted treatment and disposal facilities for metals sludge and other residuals. By employing Option (a), long-term effectiveness would also be achieved, since the source areas would be removed permanently from the site. Contrastingly, long-term effectiveness would not be achieved with Option (b), since the source areas remain on site.

Reduction of Toxicity, Mobility or Volume: Alternative GW4 would result in the reduction of toxicity, mobility, and volume of contaminants over time. The impacted groundwater would be treated to acceptable contaminant concentrations prior to discharge. In addition, these remedial measures and treatment technologies are irreversible. The on-site treatment plant would generate secondary sludge (precipitated metal hydroxides and solids), and solids wastes, such as seals, tubes, and other parts. Small quantities of spent activated carbon would be disposed/regenerated at an approved disposal facility. If Option (a) is used, then toxicity, mobility, and volume of soil contamination would also be reduced via source removal. If source removal is not performed, as described under Option (b), then there would not be any reduction in the toxicity, mobility, or volume of the source contamination.

Short-Term Effectiveness: The potential public health threats to workers and area residents would include exposure to or possibly direct contact with contaminated groundwater. The area would be secured and access would be restricted to authorized personnel only. The risk to workers would be minimized by the use of adequate preventive measures including proper PPE to prevent direct contact with contaminated groundwater. All the site activities would be in accordance with OSHA hazardous waste standards. The risk to workers and the possible health threats are more significant for Option (a) than for Option (b), due to the large volume of source material to be removed and related excavation activities associated with Option (a).

A total period of one year is estimated for this remedial alternative for planning, design, and procurement. The subsequent actual remediation period is estimated to be one year for construction of the option; however, it would take 35,000 years before ARARs/TBCs may be achieved.

Implementability:

Technical Feasibility

All the components of Alternative GW4, including Option (a) and Option (b), are well developed and commercially available for implementation at the site, and it is expected that equipment contractors and vendors would continue to be available at the time of implementation. In addition, sufficient land is available at the site for the groundwater treatment system. A long-term monitoring program would need to be instituted to assess the continuous operation of the treatment measures.

There are significant implementability issues, which are the basis for the TI waiver that is being sought site-wide for the restoration of contaminated groundwater. The justification for this waiver is based on the TI Evaluation (Appendix E), which details the extremely long time to remediate the site, the large volume of groundwater to be remediated, the high cost of this alternative, and the difficulty in extracting the inorganics from the aquifer.

Administrative Feasibility

Implementation of this alternative would require restriction of site access during the remediation process. It would be necessary to coordinate with agencies for discharge permits applications and approvals. Similarly, long-term monitoring would require regulatory attention. In order to perform the required construction activities on-site, it would be necessary to establish access facilities for the treatment plant erection and equipment installation.

Availability of Services and Materials

Adequate space is available for the on-site treatment system and staging areas during the construction of the groundwater treatment system. This alternative would utilize common construction equipment, readily available process units, and commercially-available excavation equipment, if Option (a) is used. It is anticipated that no implementation problems would be encountered. There are no feasibility issues nor services or materials associated with Option (b).

Cost: The total present worth, calculated based on a discount rate of seven percent and a 30-year period is $13,043,000. Cost breakdowns are provided in Table 4-3. Data in support of these cost estimates are presented in Appendices B and C.

4.5 COMPARISON OF ALTERNATIVES FOR SOILS

The results of the evaluation of each soil alternative with respect to the seven evaluation criteria were presented in Section 4.2. This section provides a comparative analysis which evaluates the relative performance of each alternative in relation to each specific evaluation criterion. This comparative analysis identifies advantages and disadvantages of each alternative. Table 4-1 presents a summary of the comparison of alternatives. A discussion of the comparative analysis is presented below.

4.5.1 Overall Protection of Human Health and the Environment

No remedial action objectives are achieved by Alternative SL1. Alternative SL2 relies on institutional controls to improve overall protection of human health and the environment. The perimeter security fence would limit access, although trespassing would still be possible, and ecological risks would not be mitigated. Natural processes would not effectively reduce risks in a reasonable time frame. Alternative SL3 achieves the RAOs of protecting human health and ecological receptors by preventing exposure to contaminated soil. Under Alternative SL4, contaminated material is removed from the site, thereby providing the greatest protection of human health and the environment.

4.5.2 Compliance with ARARs

Alternatives SL1, SL2, and SL3 would not achieve chemical-specific ARARs/TBCs. SL4 is the only alternative to achieve chemical-specific ARARs/TBCs. Alternatives SL3 and SL4 would meet location-specific ARARs/TBCs, Alternatives SL1 and SL2 would not. All alternatives would be expected to comply with RCRA and related state regulations applicable to the technologies being utilized.

4.5.3 Long-Term Effectiveness and Permanence

The magnitude of residual risks are highest for Alternatives SL1, SL2, reduced for Alternative SL3 and significantly reduced for Alternative SL 4.

Alternative SL2 relies on deed restrictions and perimeter fencing as control measures that are not reliable. Alternative SL3 uses soil and asphalt capping for contaminated soils and slag, which is an effective means of preventing direct contact exposure. Alternative SL4 uses source removal for contaminated soils and slag, which is a complete and irreversible means of preventing direct contact exposure. All alternatives, except SL4, would include periodic (five-year) reviews.

4.5.4 Reduction of Toxicity, Mobility or Volume

Alternatives SL1 and SL2 provide no reduction in the toxicity, mobility or volume of contaminants at the RSC. Alternative SL3 reduces the mobility of the contaminants by reducing erosion and infiltration. Alternative SL4 significantly reduces the toxicity, mobility, and volume of contaminants by removing the contaminated soils and slag material.

4.5.5 Short-Term Effectiveness

No additional short-term adverse impacts to the community would be expected from the implementation of Alternatives SL1 and SL2. Alternative SL3 would include a limited risk due to minimal disturbance of the site soils and increased truck traffic. Alternative SL4 could create particulate emissions from the source removal activities. Engineering controls would be expected to mitigate most of the risks.

Potential impacts on workers during remedial actions would be negligible for Alternatives SL1 and SL2, slightly greater for Alternative SL3, and greatest for Alternative SL4. The increasing potential impact would be created through increased construction activity and increased exposure due to larger volumes of contaminated material excavated and handled. Engineering controls, PPE and safe work practices would be used to address potential impacts to workers. Alternative SL4 also has a high potential impact to workers due to the excavation and transport of untreated materials. Proper training and engineering controls would be implemented to reduce these potential risks to workers.

No potential environmental impacts would be expected from the implementation of Alternatives SL1 and SL2 although existing impacts would remain unmitigated. For Alternatives SL3 and SL4, clearing and excavation would impact wildlife habitats; however, these areas would be restored as part of the remediation.

Although Alternatives SL1 and SL2 could be completed within several months, the natural attenuation process to reduce the hazards associated with the site would take many decades. The time estimated for implementation of Alternatives SL3 and SL4 is expected to be approximately two to four years.

4.5.6 Implementability

For Alternatives SL1 and SL2, no constructability concerns exist. Constructability concerns are associated with Alternatives SL3 and SL4. All alternatives would include periodic reviews and inspection as a means of monitoring the effectiveness of the remedy, except for Alternative SL4. Services and materials are readily available for all alternatives; however, some difficulty would be encountered due to the excessive volumes of material and the large size of the slag "boulders." There is some level of difficulty in the implementation of Alternative SL4. The first difficulty is locating an appropriate disposal facility for the excessive volumes of excavated soil. Also, there may be difficulty if the water table (i.e. groundwater) or river water is encountered during excavation of soils along the shorelines and throughout the RSC, as it may involve pumping water from excavations or dewatering soils from the deeper excavations.

4.5.7 Cost

Alternative SL1 (No Action) is the least cost alternative; there are no capital costs and no annual O&M costs (however, costs for five-year reviews in accordance with CERCLA are included). This alternative provides no protection of human health or the environment, since existing contamination is not contained, treated or removed. Alternative SL2 (Limited Action) is the next lowest cost alternative; this alternative provides minimal reduction of risk to human health by restricting site access and future use, and no protection of the environment. Alternative SL3 (Containment) is the next lowest cost alternative, and provides protection of human health and the environment through containment of the contaminated media; this is the lowest cost alternative that meets the RAOs for the site. Alternative SL4 (Source Removal/Off Site Disposal) is the highest cost alternative that also meets RAOs for the site and provides protection of human health and the environment, since all contaminated sources (i.e., soil and slag) are removed from the site.

4.6 COMPARISON OF ALTERNATIVES FOR SEDIMENTS

The results of the evaluation of each sediment alternative with respect to the seven evaluation criteria were presented in Section 4.3. This section provides a comparative analysis which evaluates the relative performance of each alternative in relation to each specific evaluation criterion. This comparative analysis identifies advantages and disadvantages of each alternative. Table 4-2 presents a summary of the comparison of alternatives. A discussion of the comparative analysis is presented below.

4.6.1 Overall Protection of Human Health and the Environment

RAOs are not achieved by Alternative SD1. Alternative SD2 relies on institutional controls to improve overall protection of human health and the environment. Natural processes would not effectively reduce risks in a reasonable time frame. Alternative SD3 achieves the remedial action objectives of protecting human health and ecological receptors by preventing exposure to contaminated sediments and restoring ecologically sensitive areas.

Alternatives SD4 and SD5 are aggressive strategies that would achieve the RAOs. Both involve dredging and dewatering of contaminated sediments that would significantly reduce the toxicity, mobility or volume of contaminants at the site. Under Alternative SD4, material is removed from the site. Under Alternative SD5, material is disposed of on-site.

4.6.2 Compliance with ARARs

Alternatives SD1 and SD2 would not achieve contaminant-specific ARARs/TBCs. Alternatives SD4 and SD5 most aggressively attempt to achieve chemical-specific ARARs/TBCs followed by Alternative SD3. All alternatives would meet location-specific ARARs/TBCs with exception of Alternatives SD1 and SD2. Permit equivalencies or ARAR waivers may be necessary for sediment dredging and remediation in wetlands. All alternatives would be expected to comply with RCRA and related state regulations applicable to the technologies being utilized.

4.6.3 Long-Term Effectiveness

The magnitude of residual risks are highest for Alternatives SD1, SD2, and SD3, and significantly reduced for Alternatives SD4 and SD5. Long-term residual risks may be lowest for Alternative SD4, which involves off-site disposal of contaminated materials.

Alternative SD2 relies on institutional control measures that are less reliable. Alternative SD3 uses capping of contaminated sediments, which is an effective means of preventing direct contact exposure, but would be subject to erosion and therefore may not be permanent. Alternative SD4 eliminates the risk associated with contaminated material from the site through disposal at an off-site facility and backfilling with clean sediments. Alternative SD5 is similar to SD4 with respect to long-term effectiveness, except that sediments are disposed on-site.

4.6.4 Reduction of Toxicity, Mobility or Volume

Alternatives SD1 and SD2 provide no reduction in the toxicity, mobility or volume of contaminants at the site. Alternative SD3 reduces the mobility of the contaminants by containment. Alternative SD4 significantly reduces the mobility and volume by disposal off-site. Alternative SD5 significantly reduces the mobility of contaminants in sediments by removal and on-site disposal.

4.6.5 Short-Term Effectiveness

No short-term adverse impacts to the community would be expected for Alternatives SD1 and SD2. Alternative SD3 would include a limited risk due to disturbance associated with the removal of 1.5 feet of sediments. Alternative SD4 would increase truck traffic and noise in the surrounding community, and would create potential hazardous waste spills in the community from the transportation of contaminated material from site. Engineering controls would be expected to minimize and/or mitigate most of the risks.

Potential impacts on workers during remedial actions would be negligible for Alternatives SD1 and SD2, slightly greater for Alternative SD3, and greatest for Alternatives SD4 and SD5. The increasing potential impact would be created through increased construction activity and increased exposure due to larger volumes of contaminated material dredged and handled. Engineering controls, PPE and safe work practices would be used to address potential impacts to workers.

No potential environmental impacts would be expected from Alternatives SD1 and SD2 although existing impacts would remain unmitigated. For Alternatives SD3 through SD5, dredging would impact wildlife habitats; however, these impacts are expected to be temporary. Construction activities would be performed so as to minimize the impacted area. Disturbance of wetland areas would be minimized to the extent possible, and protection would be provided when work must occur in these areas. Also, the site, including wetlands, would be restored upon completion of the remedial construction.

Although Alternatives SD1 and SD2 could be completed within several months, the natural attenuation process to reduce the hazards associated with the site would take many decades. The time estimated for implementation of Alternative SD3 is expected to be approximately two years. Alternatives SD4 and SD5 are estimated to require two to three years to implement. Beneficial results would begin to occur immediately upon the completion of remedial action.

4.6.6 Implementability

For Alternatives SD1 and SD2, no constructability concerns exist. Services and materials are readily available for all alternatives. Alternative SD3 would require careful construction to effectively place the cap and vegetation so as to prevent erosion. Alternative SD4 would have requirements for the transporting of waste off-site. Alternatives SD3 through SD5 would have to meet substantive requirements for dredging of sediments. Additional coordination with soil remedy implementation is also necessary for placing sediments on-site.

4.6.7 Cost

Alternative SD1 (No Action) is the least cost alternative; there are no capital costs and no annual O&M costs (however, costs for five-year reviews in accordance with CERCLA are included). This alternative provides no protection of human health or the environment, since existing contamination is not contained, treated or removed. Alternative SD2 (Institutional Controls) is the next lowest cost alternative; this alternative provides minimal reduction of risk to human health by restricting future use and no protection of the environment. Alternative SD3 (Containment) is the next lowest cost alternative, and provides protection of human health and the environment predominantly through containment of the contaminated sediments (with limited removal); this is the lowest cost alternative that meets the RAOs for the site although its effectiveness in the long term would have to be monitored.

Alternatives SD5 (Dredging/Dewatering/On-Site Disposal) and SD4 (Dredging/Dewatering/Off-Site Disposal), in order of increasing cost, are the highest cost alternatives. These alternatives meet the RAOs for the site and provide protection of human health and the environment by removal of contaminated media. Of these alternatives, Alternative SD5 may be slightly less protective, since it involves disposal on-site of the contaminated material.

4.7 COMPARISON OF ALTERNATIVES FOR GROUNDWATER

The results of the evaluation of each groundwater alternative with respect to the seven evaluation criteria were presented in Section 4.4. This section provides a comparative analysis that evaluates the relative performance of each alternative in relation to each specific evaluation criterion. This comparative analysis identifies advantages and disadvantages of each alternative. Table 4-3 presents a summary of the comparison of groundwater alternatives. A discussion of the comparative analysis is presented below.

4.7.1 Overall Protection of Human Health and the Environment

RAOs are not achieved by Alternative GW1. Alternative GW2 relies on institutional controls to improve overall protection of human health; however, it is not protective of the environment. Natural processes would not effectively reduce risks in a reasonable time frame. Alternative GW4 is an aggressive strategy that, when implemented with Option (a), would achieve the RAOs by extraction and treatment of the groundwater and would significantly reduce the toxicity, mobility or

TABLE 4-3 (Sheet 1 of 4)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
COMPARISON OF ALTERNATIVES FOR GROUNDWATER

Criterion	Alternative GW1 No Action	Alternative GW2 Limited Action	Alternative GW4 Restoration
Key Components	5-year reviews	Long-term monitoring, 5-year reviews, institutional controls,, NJDEP CEA, and well restrictions.	Groundwater pump-and-treat system with two options: Option (a) with source removal Option (b) without source removal. CEA use restrictions would also be established.
1. Overall Protection of Human Health and the Environment	Provides no protection of human health since contaminants remain on-site. Does not protect the environment.	Provides little protection of human health since contaminants remain on-site and institutional controls may be ineffective. Does not protect the environment.	Provides the most protection of all the alternatives, since the contaminants are extracted, treated, and discharged at acceptable cleanup levels. However, protection is achieved over extended time frame.
2. Compliance with ARARs			
• Chemical-specific ARARs	Does not comply.	Does not comply.	Does comply.
• Action-specific ARARs	Not applicable.	Would comply when possible; waivers obtained if necessary	Would comply when possible; waivers obtained if necessary
• Location-specific ARARs	Not applicable.	Would comply when possible; waivers obtained if necessary	Would comply when possible; waivers obtained if necessary
• Compliance with criteria, advisories and guidance	Not applicable.	Would be in compliance with federal, state and local criteria, advisories and guidance.	Would be in compliance with federal, state and local criteria, advisories and guidance.
3. Long-Term Effectiveness			
• Magnitude of residual risk	Contamination has not been removed. Existing risk would remain.	Contamination is not removed. Existing risk would remain.	Would eliminate human health and ecological risks via extraction, treatment and source removal, if used.
• Adequacy of controls	No controls. Requires 5-year reviews.	Institutional controls provide more protection than no action, but no guarantee against exposure. Long-term monitoring CEA, and use restrictions would be required.	Controls are adequate for removing contamination reducing exposure. Long-term monitoring, CEA, and use restrictions will be required.

TABLE 4-3 (Sheet 2 of 4)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
COMPARISON OF ALTERNATIVES FOR GROUNDWATER

Criterion	Alternative GW1 No Action	Alternative GW2 Limited Action	Alternative GW4 Restoration
• Reliability of controls	No controls are provided.	Institutional controls are not totally reliable. The CEA use restriction provides more protection than No Action, but there is no guarantee against exposure.	Treatment technologies are proven and used routinely as reliable measures. The CEA provides additional control.
4. Reduction of Toxicity, Mobility, or Volume			
• Treatment process and remedy	No treatment employed.	No treatment employed.	Groundwater treatment system for contaminant extraction and removal, prior to discharge.
• Amount of hazardous material destroyed or treated	None by treatment.	None by treatment.	1.7 trillion gallons of groundwater treated to cleanup levels, after 35,000 years.
• Reduction of Toxicity, Mobility, or Volume	None by treatment. No change in mobility.	None by treatment. No change in mobility.	Significantly reduces toxicity, mobility, and volume of groundwater contaminants.
• Type and quantity of treatment residuals	No treatment involved.	No treatment involved.	Treatment residuals include precipitated metals sludge and spent activated carbon.
5. Short-Term Effectiveness			
• Protection of community during remedial actions	There are no remedial actions. Risk to community not increased. No protection required.	There are no remedial actions. Risk to community not increased. No protection required.	Limited risk due to site disturbances, truck traffic, noise, and some fugitive dust emissions. Engineering controls are expected to mitigate most of the risks.
• Protection of workers during remedial actions	No remedial action involved.	No significant risk. Protection required against direct contact.	Risks due to construction activities, increased exposure to contamination, process equipment, and exposure to treatment chemicals. Engineering controls, PPE, and safe work practices required to mitigate any risks.
• Environmental impacts	Continued impact from existing conditions.	Continued impact from existing conditions.	Clearing and piping installation, would impact wildlife habitats; however, these areas would be restored.

TABLE 4-3 (Sheet 3 of 4)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
COMPARISON OF ALTERNATIVES FOR GROUNDWATER

Criterion	Alternative GW1 No Action	Alternative GW2 Limited Action	Alternative GW4 Restoration
• Time until remedial response objectives are achieved	Any natural processes would take approximately 90,000 years to reduce contaminant levels in the groundwater.	Any natural processes would take approximately 90,000 years to reduce the contaminant levels in the groundwater.	Actual remediation period estimated to be 35,000 years.
6. <u>Implementability</u>			
<u>Technical Feasibility</u>			
• Ability to construct and operate technology	No construction involved.	No major construction involved. Institutional controls are technically implementable.	Moderate difficulty in constructing and implementing a groundwater treatment system.
• Reliability of technology	No treatment technology involved.	No treatment technology involved. Long-term monitoring is reliable.	Restoration treatment technologies are reliable with the proper maintenance.
• Ease of undertaking additional remedial action, if necessary	If review indicates that more action is necessary, may need to go through the RI/FS/ROD process again.	If monitoring and/or review indicates that more action is necessary, may need to go through the RI/FS/ROD process again.	Additional remedial action can be undertaken.
• Monitoring considerations	None provided.	Long-term monitoring would be required. Migration pathways can be monitored.	Long-term monitoring would be required. Migration pathways can be monitored.
<u>Administrative Feasibility</u>			
• Coordination with other agencies	Coordination required with local agencies for reviewing the site conditions.	Coordination required with local agencies for monitoring and reviewing the site. Additional coordination needed for institutional controls.	Coordination with local agencies required for monitoring and site reviews. Water disposal may require coordination with the local POTW and/or NJDEP (for surface water discharge).
<u>Availability of Service and Materials</u>			
• Availability of treatment, storage capacity, and disposal services	No TSD facilities required.	No TSD facilities required.	TSD services are available.

TABLE 4-3 (Sheet 4 of 4)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROEBLING STEEL COMPANY SITE
COMPARISON OF ALTERNATIVES FOR GROUNDWATER

Criterion	Alternative GW1 No Action	Alternative GW2 Limited Action	Alternative GW4 Restoration
• Availability of necessary equipment, specialists, and materials	None required.	Equipment and specialists for monitoring are easily available locally.	Common construction equipment and treatment units are readily available.
• Availability of technologies	None required.	None required.	The technology and process options are available.
7. <u>Cost</u>			
• Total Capital Cost ($)	$0	$ 15,000	$ 3,455,000
• Annual operation and maintenance cost ($/yr)*	$0	$ 50,000	$ 768,000
• Present worth of operation and maintenance cost ($)**	$54,000	$671,000	$ 9,588,000
• Present worth ($ based on 7 percent discount rate and 30 year period)	$54,000	$686,000	$13,043,000

* Annual O&M excludes 5-year reviews, but includes contingency costs for repair or replacement of mechanical systems on an annual basis.
**Present worth of O&M includes 5-year reviews.

volume of contaminants over an extended time period. By using Option (a) with GW4 to remove contaminated sources, the RAOs are further achieved by preventing direct contact with and exposure to the soils and slag material. Option (b) provides for no source removal; therefore, the RAO for minimizing further adverse impacts to groundwater is not achieved and groundwater RAGs are unlikely to be achieved.

4.7.2 Compliance with ARARs

Alternative GW1 would not achieve compliance with chemical-specific ARARs since contaminants are not removed to cleanup levels. Since the source of groundwater contamination is not removed, Alternative GW2 would not achieve compliance with chemical-specific ARARs; however, location- and action-specific ARARs would be followed or waivers would be obtained as necessary. Alternative GW4 most aggressively attempts to achieve compliance with chemical-specific ARARs since the contaminated groundwater would be removed and treated. In addition, GW4 would meet location- and action-specific ARARs, or waivers would be obtained if necessary. Alternatives GW1 and GW2 do not satisfy RCRA because no site closure or remediation is accomplished. Alternative GW4 would comply with RCRA; however, it would take 35,000 years.

4.7.3 Long-Term Effectiveness and Permanence

The magnitude of residual risks are highest for Alternatives GW1, GW2, and significantly reduced for Alternative GW4.

Alternative GW2 relies on water use restrictions as control measures that are not highly reliable. Alternative GW4 extracts and treats the contaminated groundwater, thereby eliminating a larger volume of the contaminants. In addition, the remedial measures and treatment technologies used in GW4 are irreversible and permanent. By employing Option (a) as part of GW4, long-term effectiveness would also be achieved, since the source areas would be removed permanently from the site. Contrastingly, long-term effectiveness would not be achieved with Option (b), since the source areas remain on site. All alternatives would include periodic (five-year) reviews.

4.7.4 Reduction of Toxicity, Mobility or Volume

Alternatives GW1 and GW2 provide no reduction in the toxicity, mobility or volume of contaminants at the site. Over time, Alternative GW4 reduces the toxicity, mobility, and volume of the contaminants via removal and the groundwater treatment system. If Option (a) is used in conjunction with GW4, then the toxicity, mobility, and volume of soil contamination would also be reduced through source removal. If source removal is not performed, as described under Option (b), then there would not be any reduction in the toxicity, mobility, or volume of the source contamination.

4.7.5 Short-Term Effectiveness

No additional short-term adverse impacts to the community would be expected from Alternatives GW1 and GW2. Alternative GW4 would include a limited risk due to some disturbances of the site soils (during trenching and GW4 Option (a) source removal, if used), increased truck traffic, and noise during construction of the groundwater treatment system. Engineering controls would be expected to mitigate most of the risks.

Potential impacts on workers during remedial actions would be negligible for Alternatives GW1 and GW2, and greatest for Alternative GW4. The risk to workers and the possible health threats are more significant for Option (a) than for Option (b), due to the large volume of source material to be removed and related excavation activities associated with Option (a). The increasing potential impact would be created through increased construction activity and increased exposure due to larger volumes of contaminated material handled. Engineering controls, PPE and safe work practices would be used to address potential impacts to workers. Alternative GW4 has the greatest potential impact to workers due to the use of on-site, *ex situ* treatment processes. The additional equipment and treatment chemicals present additional hazards beyond the construction and handling hazards present in the other alternatives. Proper training and engineering controls would be implemented to reduce these potential risks to workers.

No potential environmental impacts would be expected from Alternatives GW1 and GW2 although existing impacts would remain unmitigated. For Alternative GW4, clearing, trenching, and source removal, if used as Option (a), would impact wildlife habitats; however, these areas would be restored as part of the remediation.

Alternatives GW1 and GW2 could be completed within several months. Alternative GW4 is expected to require one year to complete construction and installation, but it will take 35,000 years to complete the remediation. Beneficial results would begin to occur immediately upon the beginning of remedial action.

4.7.6 Implementability

For Alternatives GW1 and GW2, no constructability concerns exist. Alternative GW4 uses demonstrated and proven treatment technologies. Some engineering studies would need to occur during the design phase to optimize operating parameters. All of the alternatives would include periodic reviews and inspection as a means of monitoring the effectiveness of the remedy.

Services and materials are readily available for all of the alternatives. Since Alternative GW4 uses common and commercially-available equipment, it is anticipated that contractors and vendors would continue to be available at the time of implementation. Alternative GW4 would have additional requirements for operations, regarding hydraulic control measures and the groundwater treatment system, respectively.

4.7.7 Cost

Alternative GW1 (No Action) is the least cost alternative; there are no capital costs and no annual O&M costs (however, costs for five-year reviews in accordance with CERCLA are included). This alternative provides no protection of human health or the environment, since existing contamination is not contained, treated or removed.

Alternative GW2 (Limited Action) is the next lowest cost alternative; this alternative provides minimal reduction of risk to human health, by restricting groundwater use, and no protection of the environment.

Alternative GW4 (Restoration) is the highest cost alternative. This alternative meets the RAOs (over time) for the RSC and provides protection of human health and the environment via the removal and treatment of contaminated groundwater. Also, if Option (a) is used, additional costs are incurred due to source removal activities in conjunction with the groundwater restoration. Option (b) does not incur additional costs, as it includes no source removal activities.

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APPENDIX A

QUANTITY CALCULATIONS

Appendix A
ROEBLING STEEL COMPANY SITE FEASIBILITY STUDY
AREA / VOLUME ESTIMATES FOR CONTAMINATED MATERIALS

TABLE A-1
OU-5 SOILS

(Based on AutoCAD v.14 "Polygon Area" Calculation Routine - Refer to Figure A-1)

NAME OF AREA	AREA (FT2)	DEPTH (FT)	VOLUME (FT3)	VOLUME (YD3)
SS01	276,932.24	4	1,107,728.96	41,027.00
SS02	328,685.29	4	1,314,741.16	48,694.12
SS03	296,448.47	4	1,185,793.88	43,918.29
SS04	114,802.85	4	459,211.40	17,007.83
SS05	107,700.09	4	430,800.36	15,955.57
SS06	238,361.13	4	953,444.52	35,312.76
SS06(a)	125,571.10	4	502,284.40	18,603.13
SS06(b)	69,110.15	4	276,440.60	10,238.54
SS07	213,508.32	4	854,033.28	31,630.86
SS08	90,183.01	4	360,732.04	13,360.45
SS09	236,333.04	4	945,332.16	35,012.30
SS09(a)	69,831.52	4	279,326.08	10,345.41
SS09(b)	98,643.87	4	394,575.48	14,613.91
SS10	68,304.37	4	273,217.48	10,119.17
SS10(a)	36,450.00	10	364,500.00	13,500.00
SS11	200,953.17	4	803,812.68	29,770.84
SS11(a)	106,904.96	4	427,619.84	15,837.77
SS11(b)	15,467.79	10	154,677.90	5,728.81
SS12	107,572.58	4	430,290.32	15,936.68
SS12(a)	11,098.64	10	110,986.40	4,110.61
SS13	192,707.40	4	770,829.60	28,549.24
SS13(a)	60,750.00	10	607,500.00	22,500.00
SS14	47,060.58	4	188,242.32	6,971.94
SS15	126,727.66	4	506,910.64	18,774.47
SS15(a)	58,757.52	8	470,060.16	17,409.64
SS16	172,798.50	4	691,194.00	25,599.78
SS16(a)	242,947.55	4	971,790.20	35,992.23
SS16(b)	66,129.84	4	264,519.36	9,797.01
SS16(c)	207,690.98	4	830,763.92	30,769.03
SS16(d)	119,423.40	10	1,194,234.00	44,230.89
SS16(e)	22,147.06	10	221,470.60	8,202.61
SS17	124,928.42	4	499,713.68	18,507.91
SS17(a)	19,058.53	10	190,585.30	7,058.71
SS18	45,918.37	4	183,673.48	6,802.72
SL01	22,848.92	4	91,395.68	3,385.03
SL02	23,165.45	4	92,661.80	3,431.92
* BL2	18,979.59	4	75,918.36	2,811.79
* BL2A	2,040.82	4	8,163.28	302.34
* BL2B	1,071.43	4	4,285.72	158.73
* BL2F	2,448.98	4	9,795.92	362.81
* BL2G	2,448.98	4	9,795.92	362.81
* BL3	92,857.14	4	371,428.56	13,756.61
* BL4	8,724.49	4	34,897.96	1,292.52
* BL4A	765.31	4	3,061.24	113.38
* BL5	4,846.85	4	19,387.40	718.05
* BL8	19,779.83	4	79,119.33	2,930.35
* BL8A	510.20	4	2,040.80	75.59
* BL10	207,142.86	4	828,571.44	30,687.83
* BL12	13,775.51	4	55,102.04	2,040.82
* BL13	166,020.41	4	664,081.64	24,595.62

400310

Appendix A
ROEBLING STEEL COMPANY SITE FEASIBILITY STUDY
AREA / VOLUME ESTIMATES FOR CONTAMINATED MATERIALS

TABLE A-1 (Cont'd)
OU-5 SOILS

(Based on AutoCAD v.14 "Polygon Area" Calculation Routine - Refer to Figure A-1)

NAME OF AREA	AREA (FT2)	DEPTH (FT)	VOLUME (FT3)	VOLUME (YD3)
* BL17	17,638.08	4	70,552.30	2,613.05
* BL19	7,346.94	4	29,387.76	1,088.44
* BL23	26,938.78	4	107,755.12	3,990.93
* BL25	20,204.08	4	80,816.32	2,993.20
* BL30	8,163.27	4	32,653.08	1,209.37
* BL31	6,043.41	4	24,173.64	895.32
* BL35	1,071.43	4	4,285.72	158.73
* BL40	1,836.73	4	7,346.92	272.11
* BL78	30,561.22	4	122,244.88	4,527.59
* BL79	1,530.61	4	6,122.44	226.76
* BL84	1,632.65	4	6,530.60	241.87
* BL85	3,571.43	4	14,285.72	529.10
* BL86	58,163.27	4	232,653.08	8,616.78
* BL88	135,028.99	4	540,115.96	20,004.29
* BL90	1,632.65	4	6,530.60	241.87
* BL96	13,265.31	4	53,061.24	1,965.23
* BL97	16,326.53	4	65,306.12	2,418.75
* BL99	12,857.14	4	51,428.56	1,904.76
* BL100	1,020.41	4	4,081.64	151.17
* BL103	816.33	4	3,265.32	120.94
* BL104	1,020.41	4	4,081.64	151.17
* BL114	35,102.04	4	140,408.16	5,200.30
* BL114'	252.99	4	1,011.96	37.48
* BL115A	1,275.51	4	5,102.04	188.96
BL(b)	1,149.96	4	4,599.84	170.36
BL(c)	9,229.55	4	36,918.20	1,367.34
BL(a)	3,673.47	4	14,693.88	544.22
TOTAL ==>	**5,324,688**		**23,240,156**	**860,747**

* Soil areas below buildings will be excavated to a depth of 4 feet bgs, based on prevailing site conditions; no data are available for soil areas below buildings.

Shading denotes an excavation depth of 8 to 10 feet bgs.

400311

Appendix A
ROEBLING STEEL COMPANY SITE FEASIBILITY STUDY
AREA / VOLUME ESTIMATES FOR CONTAMINATED MATERIALS

TABLE A-2
OU-3 SOILS (SLAG MATERIAL)
AREA TO BE CONTAINED

NAME OF AREA	AREA (FT2)	DEPTH (FT)	VOLUME (FT3)	VOLUME (YD3)
Slag Disposal Area	1,481,029	13	19,170,000	710,000
TOTAL ==>	**1,481,029**	**13**	**19,170,000**	**710,000**
TOTAL ACRES ==>	**34 †**			

TABLE A-3
OU-3 SOILS (SLAG MATERIAL)
VOLUME TO BE EXCAVATED

NAME OF AREA	AREA (FT2)	DEPTH (FT)	VOLUME (FT3)	VOLUME (YD3)
Slag Disposal Area	1,481,029	13	19,170,000	710,000
TOTAL ==>	**1,481,029**	**13**	**19,170,000**	**710,000+**

TABLE A-4
OU-5 SEDIMENTS
SEDIMENT AREAS TO BE EXCAVATED TO 1.5 FT AND CAPPED

NAME OF AREA	AREA (FT2)	DEPTH (FT)	VOLUME (FT3)	VOLUME (YD3)
Area 1 of Back Channel	306,000	1.5	459,000	17,000
Area 2 of Back Channel	76,500	1.5	114,750	4,250
Area 1 of Crafts Creek	76,500	1.5	114,750	4,250
Area 2 of Crafts Creek	261,000	1.5	391,500	14,500
Area 3 of Crafts Creek	60,300	1.5	90,450	3,350
TOTAL ==>	**780,300**		**1,170,450**	**43,350**

TABLE A-5
OU-5 SEDIMENTS
SEDIMENT AREAS TO BE EXCAVATED TO 4 FT

NAME OF AREA	AREA (FT2)	DEPTH (FT)	VOLUME (FT3)	VOLUME (YD3)
Area 1 of Back Channel	306,000	4.0	1,224,000	45,333
Area 2 of Back Channel	76,500	4.0	306,000	11,333
Area 1 of Crafts Creek	76,500	4.0	306,000	11,333
Area 2 of Crafts Creek	261,000	4.0	1,044,000	38,667
Area 3 of Crafts Creek	60,300	4.0	241,200	8,933
TOTAL ==>	**780,300**		**3,121,200**	**115,600**

† Values from URS letter, "USACE Contract No. DACW41-92-D-0004. Roebling Steel Superfund Site." Prepared by Jerald W. Jacobi of URS Consultants for the Kansas City Corps of Engineers. February 27, 1996.

U.S. ENVIRONMENTAL PROTECTION AGENCY

Roebling Steel Company Site

Figure A-1

Main Plant Excavation Areas

FOSTER WHEELER ENVIRONMENTAL CORPORATION

FS Figure A-1.dwg

400313

APPENDIX B

APPENDIX B

MAJOR CONSTRUCTION COMPONENTS FOR REMEDIAL ALTERNATIVES

TABLE B-1

ALTERNATIVE SL1: NO ACTION

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
No Remedial Action			

TABLE B-2

ALTERNATIVE SL2: LIMITED ACTION

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNIT	DESCRIPTION
I. SECURITY SYSTEM			
1. Fencing	330	ft.	Install new fence (8 ft. high chain link with triple-strand barbed wire top) where required to replace existing fence.
2. Warning Signs	60		Post warning signs at every 100 ft.
II. LAND USE RESTRICTIONS	1	LS	USEPA to assist county to establish land use restrictions.
III. STORMWATER MANAGEMENT/EROSION CONTROL			
1. Clearing and Grubbing	454,200	sq. yd.	Assume light clearing and grubbing (60% of the site areas).
2. Grading	757,000	sq. yd.	Grading/compaction of site areas.
3. Vegetation	156.40	acre	Hydro-seeding including fertilization of the site areas.
IV. MOBILIZATION/DEMOBILIZATION	1	LS	Mobilization, set up and demobilization of labor and equipments.
V. HEALTH AND SAFETY	1	LS	Health and safety equipment and monitoring.

400317

TABLE B-3

ALTERNATIVE SL3: CONTAINMENT - OPTION (A)

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
I. SUPPORT FACILITIES			
1. Office Trailer	1		USEPA, NJDEP and Engineering Office. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
2. Decontamination Trailer	2		Health and safety trailer with shower facility. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
II. SOIL COVER			
Main Plant Area			
1. Clearing and Grubbing	248,400	sq. yd.	Assume light clearing and grubbing (60% of the capping areas).
2. Grading	414,000	sq. yd.	Grading/compaction of areas.
3. Permeable Liner	414,000	sq. yd.	Install geotextile fabric, 80 Mil thick non-woven polypropylene.
4. Clean Fill	207,000	cy	1.5 ft clean soil fill to support vegetation.
5. Topsoil	69,000	cy	0.5 ft. topsoil for vegetation.
6. Vegetation	85.54	acre	Hydro-seeding including fertilization on the soil cap.
Slag Disposal Area			
1. Clearing and Grubbing	99,000	sq. yd.	Assume light clearing and grubbing (60% of the capping areas).
2. Grading	165,000	sq. yd.	Grading/compaction of areas.
3. Permeable Liner	165,000	sq. yd.	Install geotextile fabric, 80 Mil thick non-woven polypropylene.

400318

TABLE B-3

ALTERNATIVE SL3: CONTAINMENT - OPTION (A)

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

	FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
	4. Clean Fill	82,500	cy	1.5 ft clean soil fill to support vegetation.
	5. Topsoil	27,500	cy	0.5 ft. topsoil for vegetation.
	6. Vegetation	34.09	acre	Hydro-seeding including fertilization on the soil cap.
	7. Riprap	36,000	cy	Riprap along slag disposal area shoreline (3600 ft. long, 15 ft deep, and 3 ft. thick at top with 1:2 side slope).
III.	ASPHALT CAP			
	1. Clearing and Grubbing	106,800	sq. yd.	Assume light clearing and grubbing (60% of the capping areas).
	2. Grading	178,000	sq. yd.	Grading/compaction of areas.
	3. Asphalt Paving	1,602,000	sq. ft.	Gravel sub-base and asphalt
	4. Stormwater Management	36.78	acre	Provide Stormwater Management System consisting of catch basins, piping and outfall structure (use existing sewer lines/outfall as much as possible and install slip lining where needed).
IV.	INSTITUTIONAL CONTROLS			
	1. Land Use Restrictions	1	LS	USEPA to assist county to establish land use restrictions.
V.	MOBILIZATION/DEMOBILIZATION	1	LS	Mobilization, set up and demobilization of labor and equipments.
VI.	HEALTH AND SAFETY	1	LS	Health and safety equipment and monitoring.

400319

TABLE B-4

ALTERNATIVE SL3: CONTAINMENT - OPTION (B)

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
I. SUPPORT FACILITIES			
1. Office Trailer	1		USEPA, NJDEP and Engineering Office. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
2. Decontamination Trailer	2		Health and safety trailer with shower facility. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
II. SOIL COVER			
Main Plant Area			
1. Clearing and Grubbing	355,200	sq. yd.	Assume light clearing and grubbing (60% of the capping areas).
2. Grading	592,000	sq. yd.	Grading/compaction of areas.
3. Permeable Liner	592,000	sq. yd.	Install geotextile fabric, 80 Mil thick non-woven polypropylene.
4. Clean Fill	296,000	cy	1.5 ft clean soil fill to support vegetation.
5. Topsoil	98,667	cy	0.5 ft. topsoil for vegetation.
6. Vegetation	122.31	acre	Hydro-seeding including fertilization on the soil cap.
Slag Disposal Area			
1. Clearing and Grubbing	99,000	sq. yd.	Assume light clearing and grubbing (60% of the capping areas).
2. Grading	165,000	sq. yd.	Grading/compaction of areas.
3. Permeable Liner	165,000	sq. yd.	Install geotextile fabric, 80 Mil thick non-woven polypropylene.

TABLE B-4

ALTERNATIVE SL3: CONTAINMENT - OPTION (B)

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
4. Clean Fill	82,500	cy	1.5 ft clean soil fill to support vegetation.
5. Topsoil	27,500	cy	0.5 ft. topsoil for vegetation.
6. Vegetation	34.09	acre	Hydro-seeding including fertilization on the soil cap.
7. Riprap	36,000	cy	Riprap along slag disposal area shoreline (3600 ft. long, 15 ft deep, and 3 ft. thick at top with 1:2 side slope).
III. INSTITUTIONAL CONTROLS			
1. Land Use Restrictions	1	LS	USEPA to assist county to establish land use restrictions.
IV. MOBILIZATION/DEMOBILIZATION	1	LS	Mobilization, set up and demobilization of labor and equipments.
V. HEALTH AND SAFETY	1	LS	Health and safety equipment and monitoring.

400321

TABLE B-5

ALTERNATIVE SL4: SOURCE REMOVAL/OFF-SITE DISPOSAL

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
I. SUPPORT FACILITIES			
1. Office Trailer	1		USEPA, NJDEP and Engineering Office. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
2. Decontamination Trailer	2		Health and safety trailer with shower facility. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
II. SOIL COVER			
Main Plant Area			
1. Clearing and Grubbing	355,200	sq. yd.	Assume light clearing and grubbing (60% of the capping areas).
2. Excavation	861,000	cy	Excavate soil in main plant area.
3. Clean Fill	762,333	cy	Clean soil fill into excavated areas.
4. Topsoil	98,667	cy	0.5 ft. topsoil for vegetation.
5. Vegetation	122.31	acre	Hydro-seeding including fertilization on the soil cap.
6. Off-site Disposal			
- Hazardous Waste	258,300	cy	Transport and dispose in an approved off-site permitted treatment, storage and disposal facility (TSDF) as a hazardous waste.
- Non-hazardous Waste	602,700	cy	Transport and dispose in an approved off-site permitted TSDF as a non-hazardous waste.

TABLE B-5

ALTERNATIVE SL4: SOURCE REMOVAL/OFF-SITE DISPOSAL

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
Slag Disposal Area			
1. Clearing and Grubbing	99,000	sq. yd.	Assume light clearing and grubbing (60% of the capping areas).
2. Excavation	710,000	cy	Excavate slag disposal area.
3. Clean Fill	682,500	cy	Clean soil fill into excavated areas.
4. Topsoil	27,500	cy	0.5 ft. topsoil for vegetation.
5. Vegetation	34.09	acre	Hydro-seeding including fertilization on the soil cap.
6. Off-site Disposal			
- Hazardous Waste	213,000	cy	Transport and dispose in an approved off-site permitted TSDF as a hazardous waste.
- Non-hazardous Waste	497,000	cy	Transport and dispose in an approved off-site permitted TSDF as a non-hazardous waste.
7. Riprap	36,000	cy	Riprap along slag disposal area shoreline (3600 ft. long, 15 ft deep, and 3 ft. thick at top with 1:2 side slope).
III. MOBILIZATION/DEMOBILIZATION	1	LS	Mobilization, set up and demobilization of labor and equipments.
IV. HEALTH AND SAFETY	1	LS	Health and safety equipment and monitoring.

400323

TABLE B-6

ALTERNATIVE SL5: EXCAVATION/SOIL WASHING/ON-SITE BACKFILL

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
I. SUPPORT FACILITIES			
1. Office Trailer	1		USEPA, NJDEP and Engineering Office. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
2. Decontamination Trailer	2		Health and safety trailer with shower facility. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
II. SOIL COVER			
Main Plant Area			
1. Clearing and Grubbing	355,200	sq. yd.	Assume light clearing and grubbing (60% of the capping areas).
2. Excavation	861,000	cy	Excavate soil in main plant area.
3. Soil Washing	861,000	cy	Treat excavated soil using soil washing treatment system.
4. Backfill	861,000	cy	Backfill treated soil into the excavated areas.
5. Topsoil	98,667	cy	0.5 ft. topsoil for vegetation.
6. Vegetation	122.31	acre	Hydro-seeding including fertilization on the soil cap.
Slag Disposal Area			
1. Clearing and Grubbing	99,000	sq. yd.	Assume light clearing and grubbing (60% of the capping areas).
2. Excavation	710,000	cy	Excavate slag disposal area.
3. Soil Washing	710,000	cy	Treat excavated soil using soil washing treatment system.

TABLE B-6

ALTERNATIVE SL5: EXCAVATION/SOIL WASHING/ON-SITE BACKFILL

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
4. Backfill	710,000	cy	Backfill treated soil into the excavated areas.
5. Topsoil	27,500	cy	0.5 ft. topsoil for vegetation.
6. Vegetation	34.09	acre	Hydro-seeding including fertilization on the soil cap.
7. Riprap	36,000	cy	Riprap along slag disposal area shoreline (3600 ft. long, 15 ft deep, and 3 ft. thick at top with 1:2 side slope).
III. MOBILIZATION/DEMOBILIZATION	1	LS	Mobilization, set up and demobilization of labor and equipments.
IV. HEALTH AND SAFETY	1	LS	Health and safety equipment and monitoring.

400325

TABLE B-7

ALTERNATIVE SL6: IN SITU STABILIZATION/CONTAINMENT - OPTION (A)

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
I. SUPPORT FACILITIES			
1. Office Trailer	1		USEPA, NJDEP and Engineering Office. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
2. Decontamination Trailer	2		Health and safety trailer with shower facility. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
II. IN SITU STABILIZATION AND SOIL COVER			
Main Plant Area			
1. Clearing and Grubbing	248,400	sq. yd.	Assume light clearing and grubbing (60% of the capping areas).
2. In Situ Stabilization	861,000	cy	Stabilize the soil in the plant areas.
3. Grading	414,000	sq. yd.	Grading/compaction of areas.
4. Clean Fill	207,000	cy	1.5 ft clean soil fill to support vegetation.
5. Topsoil	69,000	cy	0.5 ft. topsoil for vegetation.
6. Vegetation	85.54	acre	Hydro-seeding including fertilization on the soil cap.
Slag Disposal Area			
1. Clearing and Grubbing	99,000	sq. yd.	Assume light clearing and grubbing (60% of the capping areas).
2. In Situ Stabilization	710,000	cy	Stabilize the soil in the slag disposal areas.
3. Grading	165,000	sq. yd.	Grading/compaction of areas.

TABLE B-7

ALTERNATIVE SL6: IN SITU STABILIZATION/CONTAINMENT - OPTION (A)

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
4. Clean Fill	82,500	cy	1.5 ft clean soil fill to support vegetation.
5. Topsoil	27,500	cy	0.5 ft. topsoil for vegetation.
6. Vegetation	34.09	acre	Hydro-seeding including fertilization on the soil cap.
7. Riprap	36,000	cy	Riprap along slag disposal area shoreline (3600 ft. long, 15 ft deep, and 3 ft. thick at top with 1:2 side slope).
III. IN SITU STABILIZATION AND ASPHALT CAP			
1. Clearing and Grubbing	106,800	sq. yd.	Assume light clearing and grubbing (60% of the capping areas).
2. Grading	178,000	sq. yd.	Grading/compaction of areas.
3. Asphalt Paving	1,602,000	sq. ft.	Gravel sub-base and asphalt
IV. INSTITUTIONAL CONTROLS			
1. Land Use Restrictions	1	LS	USEPA to assist county to establish land use restrictions.
V. MOBILIZATION/DEMOBILIZATION	1	LS	Mobilization, set up and demobilization of labor and equipments.
VI. HEALTH AND SAFETY	1	LS	Health and safety equipment and monitoring.

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TABLE B-8

ALTERNATIVE SL6: IN SITU STABILIZATION/CONTAINMENT - OPTION (B)

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
I. SUPPORT FACILITIES			
1. Office Trailer	1		USEPA, NJDEP and Engineering Office. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
2. Decontamination Trailer	2		Health and safety trailer with shower facility. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
II. IN SITU STABILIZATION AND SOIL COVER			
Main Plant Area			
1. Clearing and Grubbing	355,200	sq. yd.	Assume light clearing and grubbing (60% of the capping areas).
2. In Situ Stabilization	861,000	cy	Stabilize the soil in the plant areas.
3. Grading	592,000	sq. yd.	Grading/compaction of areas.
4. Clean Fill	296,000	cy	1.5 ft clean soil fill to support vegetation.
5. Topsoil	98,667	cy	0.5 ft. topsoil for vegetation.
6. Vegetation	122.31	acre	Hydro-seeding including fertilization on the soil cap.
Slag Disposal Area			
1. Clearing and Grubbing	99,000	sq. yd.	Assume light clearing and grubbing (60% of the capping areas).
2. In Situ Stabilization	710,000	cy	Stabilize the soil in the slag disposal areas.
3. Grading	165,000	sq. yd.	Grading/compaction of areas.

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TABLE B-8

ALTERNATIVE SL6: IN SITU STABILIZATION/CONTAINMENT - OPTION (B)

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION		ESTIMATED QUANTITIES	UNITS	DESCRIPTION
	4. Clean Fill	82,500	cy	1.5 ft clean soil fill to support vegetation.
	5. Topsoil	27,500	cy	0.5 ft. topsoil for vegetation.
	6. Vegetation	34.09	acre	Hydro-seeding including fertilization on the soil cap.
	7. Riprap	36,000	cy	Riprap along slag disposal area shoreline (3600 ft. long, 15 ft deep, and 3 ft. thick at top with 1:2 side slope).
III.	INSTITUTIONAL CONTROLS			
	1. Land Use Restrictions	1	LS	USEPA to assist county to establish land use restrictions.
IV.	MOBILIZATION/DEMOBILIZATION	1	LS	Mobilization, set up and demobilization of labor and equipments.
V.	HEALTH AND SAFETY	1	LS	Health and safety equipment and monitoring.

TABLE B-9

ALTERNATIVE SD1: NO ACTION

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
No Remedial Action			

400330

TABLE B-10

ALTERNATIVE SD2: LIMITED ACTION

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNIT	DESCRIPTION
I. LAND USE RESTRICTIONS	1	LS	USEPA to assist county to establish land use restrictions.

TABLE B-11

ALTERNATIVE SD3: CONTAINMENT

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
I. SUPPORT FACILITIES			
1. Office Trailer	1		USEPA, NJDEP and Engineering Office. Lease for 12 months (size 15 ft. L x 7. 5 ft. W x 7 ft. H)
2. Decontamination Trailer	1		Health and safety trailer with shower facility. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
II. SOIL COVER			
1. Dredging	43,500	cy	Dredge contaminated sediments to 1.5 ft. deep.
2. Sandy Loam Fill	43,500	cy	1.5 ft. clean sandy loam soil fill to support wetland vegetation.
3. Vegetation	87,000	sq. yd.	Plant wetland plants on the soil cover.
4. Dewater Sediment	43,500	cy	Dewater sediments and collect wastewater.
5. On-site Disposal	43,500	cy	Transport and dispose dewatered sediments on site.
6. Treatment and Disposal of Wastewater	5,452,920	gallon	Treat and dispose wastewater generated during dewatering of sediments.
III. INSTITUTIONAL CONTROLS			
1. Land Use Restrictions	1	LS	USEPA to assist county to establish land use restrictions.
IV. MOBILIZATION/DEMOBILIZATION	1	LS	Mobilization, set up and demobilization of labor and equipments.
V. HEALTH AND SAFETY	1	LS	Health and safety equipment and monitoring.

TABLE B-12

ALTERNATIVE SD4: DREDGING/DEWATERING/OFF-SITE DISPOSAL

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
I. SUPPORT FACILITIES			
1. Office Trailer	1		USEPA, NJDEP and Engineering Office. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
2. Decontamination Trailer	1		Health and safety trailer with shower facility. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
II. SOIL COVER			
1. Dredging	116,000	cy	Dredge contaminated sediments to 1.5 ft. deep.
2. Sandy Loam Fill	43,500	cy	1.5 ft. clean sandy loam soil fill to support wetland vegetation.
3. Sediment Fill	72,500	cy	2.5 ft. sandy soil fill.
4. Vegetation	87,000	sq. yd.	Plant wetland plants on the soil cover.
5. Dewater Sediment	116,000	cy	Dewater sediments and collect wastewater.
6. Off-site Disposal	116,000	cy	Transport and dispose dewatered sediments in an approved off-site permitted TSDF as a non-hazardous waste.
7. Treatment and Disposal of Wastewater	13,900,000	gallon	Treat and dispose wastewater generated during dewatering of sediments.
III. MOBILIZATION/DEMOBILIZATION	1	LS	Mobilization, set up and demobilization of labor and equipments.
IV HEALTH AND SAFETY	1	LS	Health and safety equipment and monitoring.
V. SHORT-TERM MAINTENANCE (contingency)			
1. Sediment Monitoring	3	yr	Annual monitoring of soil cover.
2. Maintenance	3	yr	Maintenance of soil cover (8% of capital cost, except for dredging, dewatering, and disposal of sediments and wastewater).

TABLE B-13

ALTERNATIVE SD5: DREDGING/DEWATERING/ON-SITE DISPOSAL

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
I. SUPPORT FACILITIES			
1. Office Trailer	1		USEPA, NJDEP and Engineering Office. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
2. Decontamination Trailer	1		Health and safety trailer with shower facility. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H)
II. SOIL COVER			
1. Dredging	116,000	cy	Dredge contaminated sediments to 1.5 ft. deep.
2. Sandy Loam Fill	43,500	cy	1.5 ft. clean sandy loam soil fill to support wetland vegetation.
3. Sediment Fill	72,500	cy	2.5 ft. sandy soil fill.
4. Vegetation	87,000	sq. yd.	Plant wetland plants on the soil cover.
5. Dewater Sediment	116,000	cy	Dewater sediments and collect wastewater.
6. On-site Disposal	116,000	cy	Transport and dispose dewatered sediments on site.
7. Treatment and Disposal of Wastewater	13,900,000	gallon	Treat and dispose wastewater generated during dewatering of sediments.
III. MOBILIZATION/DEMOBILIZATION	1	LS	Mobilization, set up and demobilization of labor and equipments.
IV. HEALTH AND SAFETY	1	LS	Health and safety equipment and monitoring.
V. SHORT-TERM MAINTENANCE (contingency)			
1. Sediment Monitoring	3	yr	Annual monitoring of soil cover.
2. Maintenance	3	yr	Maintenance of soil cover (8% of capital cost, except for dredging, dewatering, and disposal of sediments and wastewater).

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TABLE B-14

ALTERNATIVE GW1: NO ACTION

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
No Remedial Action			

TABLE B-15

ALTERNATIVE GW2: LIMITED ACTION

MAJOR FACILITIES AND CONSTRUCTION COMPONENTS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
I. GROUNDWATER USE RESTRICTIONS	1	LS	USEPA to assist county to establish groundwater use restrictions.

TABLE B-16

ALTERNATIVE GW3: CONTAINMENT VIA BARRIER WALLS

FACILITY/CONSTRUCTION		ESTIMATED QUANTITIES	UNITS	DESCRIPTION
I.	SUPPORT FACILITIES			
	1. Office Trailer	1		USEPA, NJDEP and Engineering Office. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H
	2. Decontamination Trailer	1		Health and safety trailer with shower facility. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft
II.	BARRIER WALLS	132,600	sq. ft.	Water tight steel sheet pile barrier wall, length 1950 ft., depth varies 63 ft. to 73 ft.
III.	GROUNDWATER EXTRACTION			
	1. Extraction Wells	7		Stainless steel 6" diameter, 63 to 73 ft. deep wells with 40 ft. stainless steel screen.
	2. Pumps	7		Submersible pump, flow rate 11 gpm each, TDH 100 ft.
	3. Piping	500	ft.	1 inch diameter, HDPE pipe buried 3.5 ft. below ground.
		2,500	ft.	3 inch diameter, HDPE pipe buried 3.5 ft. below ground.
	4. Pilot Pump Test	1		72 hours pump testing.
IV.	COLLECTION/EQUALIZATION TANK			
	1. Collection Tank	1		9,500 gals. (plus free board), epoxy coated carbon steel tank.
	2. Pumps	2		77 gpm each centrifugal pump (one operating, one standby), 40 ft. TDH, stainless steel.
	3. Piping	50	ft.	3 inch diameter, CPVC pipe.
V.	CHEMICAL PRECIPITATION SYSTEM			
	1. Rapid Mix Tank	1		200 gallon epoxy lined carbon steel tank with rapid mixer.
	2. Flocculator	1		800 gallon epoxy lined carbon steel tank with paddle mixer for flocculation.
	3. Clarifier	1		77 gpm Lamella type clarifier with sludge collection arrangement, carbon steel construction with epoxy lining.

TABLE B-16

ALTERNATIVE GW3: CONTAINMENT VIA BARRIER WALLS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
4. Caustic Feed Tank	1		250 gallon fiber glass reinforced tank to hold 25% NaOH.
5. Caustic Feed Pumps	2		1-50 ml/min each (one operating, one standby), stainless steel metering pump.
6. Ferric Chloride Feed Tank	1		250 gallon fiber glass reinforced tank.
7. Ferric Chloride Feed Pumps	2		1-50 ml/min each (one operating, one standby), stainless steel metering pump.
8. Polymer Feed Tank	1		50 gallon fiber glass reinforced tank.
9. Polymer Feed Pumps	2		1-30 ml/min each (one operating, one standby), stainless steel metering pump.
10. Sulfuric Acid Feed Tank	1		125 gallon fiber glass reinforced tank.
11. Sulfuric Acid Feed Pumps	2		1-30 ml/min each (one operating, one standby), stainless steel metering pump.
12. Process Piping	50	ft.	3 inch diameter, CPVC pipe.
	200	ft.	1 inch diameter, CPVC pipe.
VI. FILTRATION SYSTEM			
1. Filter Feed Water Sump	1		800 gallon carbon steel tank with epoxy lining.
2. Filter Feed Pumps	2		77 gpm each centrifugal pump (one operating, one standby), 40 ft. TDH, stainless steel.
3. Process Piping	50	ft.	3 inch diameter, CPVC pipe.
4. Dual Media Pressure Filters	2		4.5 ft. diameter by 8 ft. high dual media filter complete with backwash pump and automatic controls (one operating, one standby). Filters filled with 32 cubic. ft. of .99 mm anthracite and 32 cubic. ft. of 0.5 mm sand and internal flow distribution system, carbon steel construction.
VII. SLUDGE HANDLING SYSTEM			
1. Clarifier Sludge Pumps	2		1.2 gpm each (one operating, one standby), carbon steel diaphragm pump.
2. Sludge Thickener Tank	1		3,500 gallon carbon steel tank with epoxy lining.

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TABLE B-16

ALTERNATIVE GW3: CONTAINMENT VIA BARRIER WALLS

FACILITY/CONSTRUCTION		ESTIMATED QUANTITIES	UNITS	DESCRIPTION
	3. Filter Press	1		1.2 gpm, suitable for intermittent operation.
	4. Filtrate Pumps	2		1.2 gpm each (one operating, one standby), carbon steel diaphragm pump.
	5. Process Piping	200	ft.	1 inch diameter, CPVC pipe.
VIII.	LIQUID PHASE CARBON ADSORPTION SYSTEM			
	1. Activated Carbon Adsorber	1		77 gpm down flow disposable carbon adsorber in two vessels with 2,000 lbs granular activated carbon, complete with valves and controls (calgon or equivalent).
	2. Process Piping	50	ft.	3 inch diameter, CPVC pipe.
IX.	DISCHARGE SYSTEM			
	1. Treated Water Holding Tank	1		1,600 gallon carbon steel holding tank.
	2. Treated Water Discharge Pumps	2		77 gpm each centrifugal pump (one operating, one standby), 40 ft. TDH, stainless steel.
	3. Piping	600	ft.	3 inch diameter, CPVC pipe.
	4. Outfall Structure	1		One outfall structure at the Delaware River.
X.	ELECTRICALS	1	LS	For above treatment facility.
XI.	INSTRUMENTATION AND CONTROLS	1	LS	For above treatment facility.
XII.	UTILITIES (Water, Phones, etc.)	1	LS	For above treatment facility.
XIII.	FOUNDATIONS, PADS AND PREFABRICATED BUILDINGS	1	LS	For above treatment facility.
XIV.	INSTITUTIONAL CONTROLS			
	1. Water Use Restrictions	1	LS	USEPA to assist county to establish groundwater use restrictions.

TABLE B-16

ALTERNATIVE GW3: CONTAINMENT VIA BARRIER WALLS

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
XV. HEALTH AND SAFETY	1	LS	Health and safety equipment and monitoring.
XVI. MOBILIZATION/DEMOBILIZATION	1	LS	Mobilization, set up and demobilization of labor and equipments.

NOTE:

** The groundwater treatment system is designed to account for an influent flow variation up to 10%.

TABLE B-17

ALTERNATIVE GW4: RESTORATION (EXTRACTION WELLS FOR PUMP-AND-TREAT)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
I. SUPPORT FACILITIES			
1. Office Trailer	1		USEPA, NJDEP and Engineering Office. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft. H
2. Decontamination Trailer	1		Health and safety trailer with shower facility. Lease for 12 months (size 15 ft. L x 7.5 ft. W x 7 ft
II. GROUNDWATER EXTRACTION			
1. Extraction Wells	2		Stainless steel 6" diameter, 85 ft. deep wells with 40 ft. stainless steel screen.
	3		Stainless steel 6" diameter, 85 ft. deep wells with 40 ft. stainless steel screen.
	3		Stainless steel 6" diameter, 93 to 102 ft. deep wells with 40 ft. stainless steel screen.
	3		Stainless steel 6" diameter, 20 ft. deep wells with 20 ft. stainless steel screen.
	1		Stainless steel 6" diameter, 40 ft. deep wells with 20 ft. stainless steel screen.
	3		Stainless steel 6" diameter, 28 to 33 ft. deep wells with 20 ft. stainless steel screen.
2. Pumps	2		Submersible pump, flow rate 5.5 gpm each, TDH 115 ft.
	3		Submersible pump, flow rate 11 gpm each, TDH 115 ft.
	3		Submersible pump, flow rate 11 gpm each, TDH 130 ft.
	3		Submersible pump, flow rate 2.2 gpm each, TDH 70 ft.
	1		Submersible pump, flow rate 2.2 gpm each, TDH 70 ft.
	3		Submersible pump, flow rate 5.5 gpm each, TDH 70 ft.
3. Piping	500	ft.	1 inch diameter, HDPE pipe buried 3.5 ft. below ground.
	2,500	ft.	2 inch diameter, HDPE pipe buried 3.5 ft. below ground.
	500	ft.	1 inch diameter, HDPE pipe buried 3.5 ft. below ground.

TABLE B-17

ALTERNATIVE GW4: RESTORATION (EXTRACTION WELLS FOR PUMP-AND-TREAT)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
	2,500	ft.	2 inch diameter, HDPE pipe buried 3.5 ft. below ground.
	1,000	ft.	1 inch diameter, HDPE pipe buried 3.5 ft. below ground.
	2,500	ft.	2 inch diameter, HDPE pipe buried 3.5 ft. below ground.
4. Pilot Pump Test	1		72 hours pump testing.
III. COLLECTION/EQUALIZATION TANK			
1. Collection Tank	1		12,500 gals. (plus free board), epoxy coated carbon steel tank.
2. Pumps	2		102 gpm each centrifugal pump (one operating, one standby), 40 ft. TDH, stainless steel.
3. Piping	50	ft.	3 inch diameter, CPVC pipe.
IV. CHEMICAL PRECIPITATION SYSTEM			
1. Rapid Mix Tank	1		250 gallon epoxy lined carbon steel tank with rapid mixer.
2. Flocculator	1		1,000 gallon epoxy lined carbon steel tank with paddle mixer for flocculation.
3. Clarifier	1		102 gpm Lamella type clarifier with sludge collection arrangement, carbon steel construction with epoxy lining.
4. Caustic Feed Tank	1		300 gallon fiber glass reinforced tank to hold 25% NaOH.
5. Caustic Feed Pumps	2		1-50 ml/min each (one operating, one standby), stainless steel metering pump.
6. Ferric Chloride Feed Tank	1		300 gallon fiber glass reinforced tank.
7. Ferric Chloride Feed Pumps	2		1-50 ml/min each (one operating, one standby), stainless steel metering pump.
8. Polymer Feed Tank	1		100 gallon fiber glass reinforced tank.
9. Polymer Feed Pumps	2		1-30 ml/min each (one operating, one standby), stainless steel metering pump.

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TABLE B-17

ALTERNATIVE GW4: RESTORATION (EXTRACTION WELLS FOR PUMP-AND-TREAT)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
10. Sulfuric Acid Feed Tank	1		150 gallon fiber glass reinforced tank.
11. Sulfuric Acid Feed Pumps	2		1-30 ml/min each (one operating, one standby), stainless steel metering pump.
12. Process Piping	50	ft.	3 inch diameter, CPVC pipe.
	100	ft.	1 inch diameter, CPVC pipe.
V. FILTRATION SYSTEM			
1. Filter Feed Water Sump	1		1,000 gallon carbon steel tank with epoxy lining.
2. Filter Feed Pumps	2		102 gpm each centrifugal pump (one operating, one standby), 40 ft. TDH, stainless steel.
3. Process Piping	50	ft.	3 inch diameter, CPVC pipe.
4. Dual Media Pressure Filters	2		5 ft. diameter by 8 ft. high dual media filter complete with backwash pump and automatic controls (one operating, one standby). Filters filled with 40 cubic. ft. of .99 mm anthracite and 40 cubic. ft. of 0.5 mm sand and internal flow distribution system, carbon steel construction.
VI. SLUDGE HANDLING SYSTEM			
1. Clarifier Sludge Pumps	2		1.5 gpm each (one operating, one standby), carbon steel diaphragm pump.
2. Sludge Thickener Tank	1		4,500 gallon carbon steel tank with epoxy lining.
3. Filter Press	1		1.5 gpm, suitable for intermittent operation.
4. Filtrate Pumps	2		1.5 gpm each (one operating, one standby), carbon steel diaphragm pump.
5. Process Piping	200	ft.	1 inch diameter, CPVC pipe.
VII. LIQUID PHASE CARBON ADSORPTION SYSTEM			
1. Activated Carbon Adsorber	1		102 gpm down flow disposable carbon adsorber in two vessels with 2,000 lbs granular activated carbon, complete with valves and controls (Calgon or equivalent).

TABLE B-17

ALTERNATIVE GW4: RESTORATION (EXTRACTION WELLS FOR PUMP-AND-TREAT)

	FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	DESCRIPTION
	2. Process Piping	50	ft.	3 inch diameter, CPVC pipe.
VIII.	DISCHARGE SYSTEM			
	1. Treated Water Holding Tank	1		2,000 gallon carbon steel holding tank.
	2. Treated Water Discharge Pumps	2		102 gpm each centrifugal pump (one operating, one standby), 40 ft. TDH, stainless steel.
	3. Piping	600	ft.	3 inch diameter, CPVC pipe.
	4. Outfall Structure	1		One outfall structure at the Delaware River.
IX.	ELECTRICALS	1	LS	For above treatment facility.
X.	INSTRUMENTATION AND CONTROLS	1	LS	For above treatment facility.
XI.	UTILITIES (Water, Phones, etc.)	1	LS	For above treatment facility.
XII.	FOUNDATIONS, PADS AND PREFABRICATED BUILDINGS	1	LS	For above treatment facility.
XIII.	INSTITUTIONAL CONTROLS			
	1. Water Use Restrictions	1	LS	USEPA to assist county to establish groundwater use restrictions.
XIV.	HEALTH AND SAFETY	1	LS	Health and safety equipment and monitoring.
XV.	MOBILIZATION/DEMOBILIZATION	1	LS	Mobilization, set up and demobilization of labor and equipments.

NOTE:

** The groundwater treatment system is designed to account for an influent flow variation up to 10%.

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APPENDIX C

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APPENDIX C

COST ESTIMATES

TABLE C-1

ALTERNATIVE SL1: NO ACTION

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
No Remedial Action							

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TABLE C-2

ALTERNATIVE SL1: NO ACTION

OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	FIVE YEAR REVIEWS	$25,000 per review	$25,000.00	5, 10, 15, 20, 25, 30
	Present Worth of Reviews	For every 5 year, @7% discount rate	$53,900.00	
	Total Present Worth of O&M		$53,900.00	

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TABLE C-3

ALTERNATIVE SL2: LIMITED ACTION

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNIT	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. SECURITY SYSTEM							
1. Fencing	330	ft.	Included in installation cost		$27.00	$8,910.00	$8,910.00
2. Warning Signs	60				$60.00	$3,600.00	$3,600.00
II. LAND USE RESTRICTIONS	1	LS			$15,100.00	$15,100.00	$15,100.00
III. STORMWATER MANAGEMENT/ EROSION CONTROL							
1. Clearing and Grubbing	454,200	sq. yd.			$0.30	$136,260.00	$136,260.00
2. Grading	757,000	sq. yd.			$0.77	$582,890.00	$582,890.00
3. Vegetation	156.40	acre			$2,670.00	$417,601.24	$417,601.24
IV. MOBILIZATION/DEMOBILIZATION	1	LS			$12,000.00	$12,000.00	$12,000.00
V. HEALTH AND SAFETY	1	LS			$60,000.00	$60,000.00	$60,000.00

Total Direct Construction Cost (TDCC)	$1,236,361.24
Contingency @ 20% of TDCC	$247,272.25
Engineering and Construction Management @ 15% of TDCC	$185,454.19
Legal and Administration @ 5% of TDCC	$61,818.06
Total Construction Cost	$1,730,905.74

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TABLE C-4

ALTERNATIVE SL2: LIMITED ACTION

OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
	1. Monitoring of Soil (e.g., soil erosion)	1 person @ $60/hr - 8 hrs/yr, ODCs for travel, safety supplies @ $100 per/yr.	$1,060.00	1 - 30
	2. Report	1 person @ $80/hr - 4hrs/yr	$320.00	1 - 30
II.	SITE SECURITY SERVICES	2 Guards, 24 hr/day	$272,000.00	1 - 30
III.	MAINTENANCE	1% of capital cost (excluding Land Use Restrictions) and also include replacement of fence (330 ft. long each year)*	$29,446.92	1 - 30
IV.	CONTINGENCY	5% of annual O&M cost	$15,141.35	1 - 30
		10% of total capital cost incurred in year 3**	$169,729.17	3
	Total Annual O&M		$317,968.26	
	Present Worth of O&M (excl. reviews)	For 30 year O&M, @7% discount rate	$4,084,217.74	
V.	FIVE-YEAR REVIEWS	$25,000 per review	$25,000.00	5, 10, 15, 20, 25, 30
	Present Worth of Reviews	For every 5 year, @7% discount rate	$53,900.00	
	Total Present Worth of O&M		$4,138,117.74	

* Typical annual maintenance costs for a passive remedy are estimated to be 1% of the capital cost of the remedy, excluding costs for Land Use Restrictions. For this alternative, maintenance costs include minor maintenance of stormwater/erosion controls (e.g., regrading/ revegetating up to ~4 acres). The cost for replacement of up to 330 feet of security fence per year has also been included as a maintenance item. Costs for watering, mowing, topsoil, and dust control are not included.

** A one time cost of 10% of the capital cost, excluding Land Use Restrictions, is estimated for year 3, as a contingency for failure of a component of the remedy.

TABLE C-5

ALTERNATIVE SL3: CONTAINMENT - OPTION (A)

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. SUPPORT FACILITIES							
1. Office Trailer	1		Included in installation cost		$14,400.00	$14,400.00	$14,400.00
2. Decontamination Trailer	2				$28,200.00	$56,400.00	$56,400.00
II. SOIL COVER							
Main Plant Area							
1. Clearing and Grubbing	248,400	sq. yd.			$0.30	$74,520.00	$74,520.00
2. Grading	414,000	sq. yd.			$0.77	$318,780.00	$318,780.00
3. Permeable Liner	414,000	sq. yd.			$1.08	$447,120.00	$447,120.00
4. Clean Fill	207,000	cy			$14.00	$2,898,000.00	$2,898,000.00
5. Topsoil	69,000	cy			$23.47	$1,619,430.00	$1,619,430.00
6. Vegetation	85.54	acre			$2,670.00	$228,384.30	$228,384.30
Slag Disposal Area							
1. Clearing and Grubbing	99,000	sq. yd.			$0.30	$29,700.00	$29,700.00
2. Grading	165,000	sq. yd.			$0.77	$127,050.00	$127,050.00
3. Permeable Liner	165,000	sq. yd.			$1.08	$178,200.00	$178,200.00
4. Clean Fill	82,500	cy			$14.00	$1,155,000.00	$1,155,000.00
5. Topsoil	27,500	cy			$23.47	$645,425.00	$645,425.00
6. Vegetation	34.09	acre			$2,670.00	$91,022.73	$91,022.73
7. Riprap	36,000	cy			$40.00	$1,440,000.00	$1,440,000.00
III. ASPHALT CAP							
1. Clearing and Grubbing	106,800	sq. yd.			$0.30	$32,040.00	$32,040.00
2. Grading	178,000	sq. yd.			$0.77	$137,060.00	$137,060.00
3. Asphalt Paving	1,602,000	sq. ft.			$1.88	$3,011,760.00	$3,011,760.00
4. Stormwater Management	36.78	acre			$42,000.00	$1,544,628.10	$1,544,628.10
IV. INSTITUTIONAL CONTROLS							
1. Land Use Restrictions	1	LS			$15,100.00	$15,100.00	$15,100.00
V. MOBILIZATION/DEMOBILIZATION	1	LS			$47,500.00	$47,500.00	$47,500.00
VI. HEALTH AND SAFETY	1	LS			$240,000.00	$240,000.00	$240,000.00
	Total Direct Construction Cost (TDCC)						$14,351,520.12
	Contingency @ 20% of TDCC						$2,870,304.02
	Engineering and Construction Management @ 15% of TDCC						$2,152,728.02
	Legal and Administration @ 5% of TDCC						$717,576.01
	Total Construction Cost						$20,092,128.17

TABLE C-6

ALTERNATIVE SL3: CONTAINMENT - OPTION (A)

OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
	1. Monitoring of Soil (e.g., soil erosion)	1 person @ $60/hr - 8 hrs/yr, ODCs for travel, safety supplies @ $100 per/yr.	$1,060.00	1 - 30
	2. Report	1 person @ $80/hr - 4hrs/yr	$320.00	1 - 30
II.	MAINTENANCE	1% of capital cost*	$200,921.28	1 - 30
III.	CONTINGENCY	5% of annual O&M cost	$10,115.06	1 - 30
		10% of capital cost incurred in year 3**	$2,009,212.82	3
	Total Annual O&M		$212,416.35	
	Present Worth of O&M (excl. reviews)	For 30 year O&M, @7% discount rate	$4,275,990.59	
IV.	FIVE-YEAR REVIEWS	$25,000 per review	$25,000.00	5, 10, 15, 20, 25,
	Present Worth of Reviews	For every 5 year, @7% discount rate	$53,900.00	
	Total Present Worth of O&M		$4,329,890.59	

* Typical annual maintenance costs for a passive remedy are estimated to be 1% of the capital cost of the remedy. Maintenance costs for this alternative include general cap maintenance, such as mowing 10 times per year, patching ~2 acres of asphalt, regrading/reseeding up to ~5 acres, and minor maintenance of the stormwater management system (e.g., clearing of inlets and chambers). Costs for replacement of any failed component of the remedy, watering, topsoil, and dust control are not included.

** A one time cost of 10% of the capital cost is estimated for year 3, as a contingency for failure of a component of the remedy.

TABLE C-7

ALTERNATIVE SL3: CONTAINMENT - OPTION (B)

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. SUPPORT FACILITIES							
1. Office Trailer	1		Included in installation cost		$14,400.00	$14,400.00	$14,400.00
2. Decontamination Trailer	2				$28,200.00	$56,400.00	$56,400.00
II. SOIL COVER							
Main Plant Area							
1. Clearing and Grubbing	355,200	sq. yd.			$0.30	$106,560.00	$106,560.00
2. Grading	592,000	sq. yd.			$0.77	$455,840.00	$455,840.00
3. Permeable Liner	592,000	sq. yd.			$1.08	$639,360.00	$639,360.00
4. Clean Fill	296,000	cy			$14.00	$4,144,000.00	$4,144,000.00
5. Topsoil	98,667	cy			$23.47	$2,315,706.67	$2,315,706.67
6. Vegetation	122.31	acre			$2,670.00	$326,578.51	$326,578.51
Slag Disposal Area							
1. Clearing and Grubbing	99,000	sq. yd.			$0.30	$29,700.00	$29,700.00
2. Grading	165,000	sq. yd.			$0.77	$127,050.00	$127,050.00
3. Permeable Liner	165,000	sq. yd.			$1.08	$178,200.00	$178,200.00
4. Clean Fill	82,500	cy			$14.00	$1,155,000.00	$1,155,000.00
5. Topsoil	27,500	cy			$23.47	$645,425.00	$645,425.00
6. Vegetation	34.09	acre			$2,670.00	$91,022.73	$91,022.73
7. Riprap	36,000	cy			$40.00	$1,440,000.00	$1,440,000.00
III. INSTITUTIONAL CONTROLS							
1. Land Use Restrictions	1	LS			$15,100.00	$15,100.00	$15,100.00
IV. MOBILIZATION/DEMOBILIZATION	1	LS			$47,500.00	$47,500.00	$47,500.00
V. HEALTH AND SAFETY	1	LS			$240,000.00	$240,000.00	$240,000.00

Total Direct Construction Cost (TDCC)	$12,027,842.91
Contingency @ 20% of TDCC	$2,405,568.58
Engineering and Construction Management @ 15% of TDCC	$1,804,176.44
Legal and Administration @ 5% of TDCC	$601,392.15
Total Construction Cost	$16,838,980.07

400353

TABLE C-8

ALTERNATIVE SL3: CONTAINMENT - OPTION (B)

OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
	1. Monitoring of Soil (e.g., soil erosion)	1 person @ $60/hr - 8 hrs/yr, ODCs for travel, safety supplies @ $100 per/yr.	$1,060.00	1 - 30
	2. Report	1 person @ $80/hr - 4hrs/yr	$320.00	1 - 30
II.	MAINTENANCE	1% of capital cost*	$168,389.80	1 - 30
III.	CONTINGENCY	5% of annual O&M cost	$8,488.49	1 - 30
		10% of capital cost incurred in year 3**	$1,683,898.01	3
	Total Annual O&M		$178,258.29	
	Present Worth of O&M (excl. reviews)	For 30 year O&M, @7% discount rate	$3,586,569.50	
IV.	FIVE-YEAR REVIEWS	$25,000 per review	$25,000.00	5, 10, 15, 20, 25, 30
	Present Worth of Reviews	For every 5 year, @7% discount rate	$53,900.00	
	Total Present Worth of O&M		$3,640,469.50	

* Typical annual maintenance costs for a passive remedy are estimated to be 1% of the capital cost of the remedy. Maintenance costs for this alternative include general cap maintenance, such as mowing 10 times per year, regrading/reseeding up to ~10 acres, and minor maintenance of the stormwater management system (e.g., clearing of inlets and chambers). Costs for replacement of any failed component of the remedy, watering, topsoil, and dust control are not included.

** A one time cost of 10% of the capital cost, excluding one-time costs that cannot fail or require maintenance (e.g., removal and off-site disposal), is estimated for year 3, as a contingency for failure of a component of the remedy.

TABLE C-9

ALTERNATIVE SL4: SOURCE REMOVAL/OFF-SITE DISPOSAL

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. SUPPORT FACILITIES							
1. Office Trailer	1		Included in installation cost		$14,400.00	$14,400.00	$14,400.00
2. Decontamination Trailer	2				$28,200.00	$56,400.00	$56,400.00
II. SOIL COVER							
Main Plant Area							
1. Clearing and Grubbing	355,200	sq. yd.			$0.30	$106,560.00	$106,560.00
2. Excavation	861,000	cy			$2.67	$2,298,870.00	$2,298,870.00
3. Clean Fill	762,333	cy			$14.00	$10,672,666.67	$10,672,666.67
4. Topsoil	98,667	cy			$23.47	$2,315,706.67	$2,315,706.67
5. Vegetation	122.31	acre			$2,670.00	$326,578.51	$326,578.51
6. Off-site Disposal							
- Hazardous Waste	258,300	cy			$611.00	$157,821,300.00	$157,821,300.00
- Non-hazardous Waste	602,700	cy			$132.00	$79,556,400.00	$79,556,400.00
Slag Disposal Area							
1. Clearing and Grubbing	99,000	sq. yd.			$0.30	$29,700.00	$29,700.00
2. Excavation	710,000	cy			$4.27	$3,031,700.00	$3,031,700.00
3. Clean Fill	682,500	cy			$14.00	$9,555,000.00	$9,555,000.00
4. Topsoil	27,500	cy			$23.47	$645,425.00	$645,425.00
5. Vegetation	34.09	acre			$2,670.00	$91,022.73	$91,022.73
6. Off-site Disposal							
- Hazardous Waste	213,000	cy			$611.00	$130,143,000.00	$130,143,000.00
- Non-hazardous Waste	497,000	cy			$132.00	$65,604,000.00	$65,604,000.00
7. Riprap	36,000	cy			$40.00	$1,440,000.00	$1,440,000.00
III. MOBILIZATION/DEMOBILIZATION	1	LS			$47,500.00	$47,500.00	$47,500.00
IV. HEALTH AND SAFETY	1	LS			$480,000.00	$480,000.00	$480,000.00

Total Direct Construction Cost (TDCC)	$464,236,229.57
Contingency @ 20% of TDCC	$92,847,245.91
Engineering and Construction Management @ 15% of TDCC	$69,635,434.44
Legal and Administration @ 5% of TDCC	$23,211,811.48
Total Construction Cost	$649,930,721.40

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TABLE C-10

ALTERNATIVE SL4: SOURCE REMOVAL/OFF-SITE DISPOSAL

OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM	BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR

Source removed and no operation and maintenance cost anticipated.

TABLE C-11

ALTERNATIVE SL5: EXCAVATION/SOIL WASHING/ON-SITE BACKFILL

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. SUPPORT FACILITIES							
1. Office Trailer	1		Included in installation cost		$14,400.00	$14,400.00	$14,400.00
2. Decontamination Trailer	2				$28,200.00	$56,400.00	$56,400.00
II. SOIL COVER							
Main Plant Area							
1. Clearing and Grubbing	355,200	sq. yd.			$0.30	$106,560.00	$106,560.00
2. Excavation	861,000	cy			$2.67	$2,298,870.00	$2,298,870.00
3. Soil Washing	861,000	cy			$106.70	$91,868,700.00	$91,868,700.00
4. Backfill	861,000	cy			$12.00	$10,332,000.00	$10,332,000.00
5. Topsoil	98,667	cy			$23.47	$2,315,706.67	$2,315,706.67
6. Vegetation	122.31	acre			$2,670.00	$326,578.51	$326,578.51
Slag Disposal Area							
1. Clearing and Grubbing	99,000	sq. yd.			$0.30	$29,700.00	$29,700.00
2. Excavation	710,000	cy			$4.27	$3,031,700.00	$3,031,700.00
3. Soil Washing	710,000	cy			$106.70	$75,757,000.00	$75,757,000.00
4. Backfill	710,000	cy			$12.00	$8,520,000.00	$8,520,000.00
5. Topsoil	27,500	cy			$23.47	$645,425.00	$645,425.00
6. Vegetation	34.09	acre			$2,670.00	$91,022.73	$91,022.73
7. Riprap	36,000	cy			$40.00	$1,440,000.00	$1,440,000.00
III. MOBILIZATION/DEMOBILIZATION	1	LS			$47,500.00	$47,500.00	$47,500.00
IV. HEALTH AND SAFETY	1	LS			$480,000.00	$480,000.00	$480,000.00

Total Direct Construction Cost (TDCC)	$197,361,562.91
Contingency @ 20% of TDCC	$39,472,312.58
Engineering and Construction Management @ 15% of TDCC	$29,604,234.44
Legal and Administration @ 5% of TDCC	$9,868,078.15
Total Construction Cost	$276,306,188.07

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400357

TABLE C-12

ALTERNATIVE SL5: EXCAVATION/SOIL WASHING/ON-SITE BACKFILL

OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM	BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR

Source treated and no operation and maintenance cost anticipated.

400358

TABLE C-13

ALTERNATIVE SL6: IN SITU STABILIZATION/CONTAINMENT - OPTION (A)

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. SUPPORT FACILITIES							
1. Office Trailer	1		Included in installation cost		$14,400.00	$14,400.00	$14,400.00
2. Decontamination Trailer	2				$28,200.00	$56,400.00	$56,400.00
II. IN SITU STABILIZATION AND SOIL COVER							
Main Plant Area							
1. Clearing and Grubbing	248,400	sq. yd.			$0.30	$74,520.00	$74,520.00
2. In Situ Stabilization	861,000	cy			$40.00	$34,440,000.00	$34,440,000.00
3. Grading	414,000	sq. yd.			$0.77	$318,780.00	$318,780.00
4. Clean Fill	207,000	cy			$14.00	$2,898,000.00	$2,898,000.00
5. Topsoil	69,000	cy			$23.47	$1,619,430.00	$1,619,430.00
6. Vegetation	85.54	acre			$2,670.00	$228,384.30	$228,384.30
Slag Disposal Area							
1. Clearing and Grubbing	99,000	sq. yd.			$0.30	$29,700.00	$29,700.00
2. In Situ Stabilization	710,000	cy			$50.00	$35,500,000.00	$35,500,000.00
3. Grading	165,000	sq. yd.			$0.77	$127,050.00	$127,050.00
4. Clean Fill	82,500	cy			$14.00	$1,155,000.00	$1,155,000.00
5. Topsoil	27,500	cy			$23.47	$645,425.00	$645,425.00
6. Vegetation	34.09	acre			$2,670.00	$91,022.73	$91,022.73
7. Riprap	36,000	cy			$40.00	$1,440,000.00	$1,440,000.00
III. IN SITU STABILIZATION AND ASPHALT CAP							
1. Clearing and Grubbing	106,800	sq. yd.			$0.30	$32,040.00	$32,040.00
2. Grading	178,000	sq. yd.			$0.77	$137,060.00	$137,060.00
3. Asphalt Paving	1,602,000	sq. ft.			$1.88	$3,011,760.00	$3,011,760.00
IV. INSTITUTIONAL CONTROLS							
1. Land Use Restrictions	1	LS			$15,100.00	$15,100.00	$15,100.00
V. MOBILIZATION/DEMOBILIZATION	1	LS			$47,500.00	$47,500.00	$47,500.00
VI. HEALTH AND SAFETY	1	LS			$240,000.00	$240,000.00	$240,000.00

Total Direct Construction Cost (TDCC)	$82,121,572.02
Contingency @ 20% of TDCC	$16,424,314.40
Engineering and Construction Management @ 15% of TDCC	$12,318,235.80
Legal and Administration @ 5% of TDCC	$4,106,078.60
Total Construction Cost	$114,970,200.83

400359

TABLE C-14

ALTERNATIVE SL6: IN SITU STABILIZATION/CONTAINMENT - OPTION (A)

OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
	1. Monitoring of Soil (e.g., soil erosion)	1 person @ $60/hr - 8 hrs/yr, ODCs for travel, safety supplies @ $100 per/yr.	$1,060.00	
	2. Report	1 person @ $80/hr - 4hrs/yr	$320.00	1 - 30
II.	MAINTENANCE	1% of capital cost (excluding soil & slag stabilization cost)*	$170,542.01	1 - 30
III.	CONTINGENCY	5% of annual O&M cost	$8,596.10	1 - 30
		10% of capital cost incurred in year 3**	$1,705,420.08	3
	Total Annual O&M		$180,518.11	
	Present Worth of O&M (excl. reviews)	For 30 year O&M, @7% discount rate	$3,632,180.01	
IV.	FIVE-YEAR REVIEWS	$25,000 per review	$25,000.00	5, 10, 15, 20, 25, 30
	Present Worth of Reviews	For every 5 year, @7% discount rate	$53,900.00	
	Total Present Worth of O&M		$3,686,080.01	

* Typical annual maintenance costs for a passive remedy are estimated to be 1% of the capital cost of the remedy. Maintenance costs for this alternative include general cap maintenance, such as mowing 10 times per year, patching ~1 acre of asphalt, regrading/reseeding up to ~3 acres, and minor maintenance of the stormwater management system (e.g., clearing of inlets and chambers). Costs for replacement of any failed component of the remedy, watering, topsoil, and dust control are not included.

** A one time cost of 10% of the capital cost is estimated for year 3, as a contingency for failure of a component of the remedy.

TABLE C-15

ALTERNATIVE SL6: IN SITU STABILIZATION/CONTAINMENT - OPTION (B)

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. SUPPORT FACILITIES							
1. Office Trailer	1		Included in installation cost		$14,400.00	$14,400.00	$14,400.00
2. Decontamination Trailer	2				$28,200.00	$56,400.00	$56,400.00
II. IN SITU STABILIZATION AND SOIL COVER							
Main Plant Area							
1. Clearing and Grubbing	355,200	sq. yd.			$0.30	$106,560.00	$106,560.00
2. In Situ Stabilization	861,000	cy			$40.00	$34,440,000.00	$34,440,000.00
3. Grading	592,000	sq. yd.			$0.77	$455,840.00	$455,840.00
4. Clean Fill	296,000	cy			$14.00	$4,144,000.00	$4,144,000.00
5. Topsoil	98,667	cy			$23.47	$2,315,706.67	$2,315,706.67
6. Vegetation	122.31	acre			$2,670.00	$326,578.51	$326,578.51
Slag Disposal Area							
1. Clearing and Grubbing	99,000	sq. yd.			$0.30	$29,700.00	$29,700.00
2. In Situ Stabilization	710,000	cy			$50.00	$35,500,000.00	$35,500,000.00
3. Grading	165,000	sq. yd.			$0.77	$127,050.00	$127,050.00
4. Clean Fill	82,500	cy			$14.00	$1,155,000.00	$1,155,000.00
5. Topsoil	27,500	cy			$23.47	$645,425.00	$645,425.00
6. Vegetation	34.09	acre			$2,670.00	$91,022.73	$91,022.73
7. Riprap	36,000	cy			$40.00	$1,440,000.00	$1,440,000.00
III. INSTITUTIONAL CONTROLS							
1. Land Use Restrictions	1	LS			$15,100.00	$15,100.00	$15,100.00
IV. MOBILIZATION/DEMOBILIZATION	1	LS			$47,500.00	$47,500.00	$47,500.00
V. HEALTH AND SAFETY	1	LS			$240,000.00	$240,000.00	$240,000.00

Total Direct Construction Cost (TDCC)	$81,150,282.91
Contingency @ 20% of TDCC	$16,230,056.58
Engineering and Construction Management @ 15% of TDCC	$12,172,542.44
Legal and Administration @ 5% of TDCC	$4,057,514.15
Total Construction Cost	$113,610,396.07

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TABLE C-16

ALTERNATIVE SL6: IN SITU STABILIZATION/CONTAINMENT - OPTION (B)

OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
	1. Monitoring of Soil (e.g., soil erosion)	1 person @ $60/hr - 8 hrs/yr, ODCs for travel, safety supplies @ $100 per/yr.	$1,060.00	1 - 30
	2. Report	1 person @ $80/hr - 4 hrs/yr	$320.00	1 - 30
II.	MAINTENANCE	1% of capital cost (excluding soil & slag stabilization cost)*	$156,943.96	1 - 30
III.	CONTINGENCY	5% of annual O&M cost	$7,916.20	1 - 30
		10% of capital cost incurred in year 3**	$1,569,439.61	3
	Total Annual O&M		$166,240.16	
	Present Worth of O&M (excl. reviews)	For 30 year O&M, @7% discount rate	$3,344,004.35	
IV.	FIVE-YEAR REVIEWS	$25,000 per review	$25,000.00	5, 10, 15, 20, 25, 30
	Present Worth of Reviews	For every 5 year, @7% discount rate	$53,900.00	
	Total Present Worth of O&M		$3,397,904.35	

400362

* Typical annual maintenance costs for a passive remedy are estimated to be 1% of the capital cost of the remedy. Maintenance costs for this alternative include general cap maintenance, such as mowing 10 times per year, regrading/reseeding up to ~6 acres, and minor maintenance of the stormwater management system (e.g., clearing of inlets and chambers). Costs for replacement of any failed component of the remedy, watering, topsoil, and dust control are not included.

** A one time cost of 10% of the capital cost is estimated for year 3, as a contingency for failure of a component of the remedy.

TABLE C-17

ALTERNATIVE SD1: NO ACTION

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
No Remedial Action							

400363

TABLE C-18

ALTERNATIVE SD1: NO ACTION

OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	FIVE YEAR REVIEWS	$25,000 per review	$25,000.00	5, 10, 15, 20, 25, 30
	Present Worth of Reviews	For every 5 year, @7% discount rate	$53,900.00	
	Total Present Worth of O&M		$53,900.00	

400364

TABLE C-19

ALTERNATIVE SD2: LIMITED ACTION

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. LAND USE RESTRICTIONS	1	LS			$15,100.00	$15,100.00	$15,100.00
Total Direct Construction Cost (TDCC)							$15,100.00
Contingency @ 20% of TDCC							$3,020.00
Engineering and Construction Management @ 15% of TDCC							$2,265.00
Legal and Administration @ 5% of TDCC							$755.00
Total Construction Cost							$21,140.00

400365

TABLE C-20

ALTERNATIVE SD2: LIMITED ACTION

OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
	1. Sediment and Surface Water Sampling	2 persons @ $60/hr - 50 hrs/yr, ODCs for sampling equipment @ $5,000 per/yr.	$11,000.00	1 - 30
	2. Laboratory Analysis	Analysis & validation of 6 water samples @ $1,200/ sample and 8 sediment samples @ $2,500/sample	$27,200.00	1 - 30
	3. Report	1 person @ $80/hr - 80hrs/yr	$6,400.00	1 - 30
II.	MAINTENANCE	1% of capital cost (excluding Land Use Restrictions)*	$0.00	1 - 30
III.	CONTINGENCY	5% of annual O&M cost 10% of capital cost incurred in year 3**	$2,230.00 $0.00	1 - 30 3
	Total Annual O&M		$46,830.00	
	Present Worth of O&M (excl. reviews)	For 30 year O&M, @7% discount rate	$581,113.47	
IV.	FIVE-YEAR REVIEWS	$25,000 per review	$25,000.00	5, 10, 15, 20, 25, 30
	Present Worth of Reviews	For every 5 year, @7% discount rate	$53,900.00	
	Total Present Worth of O&M		$635,013.47	

* No maintenance costs are estimated for this alternative, since only administrative actions are taken.

** No contingency costs for remedy failure are estimated for this alternative, since only administrative actions are taken.

TABLE C-21

ALTERNATIVE SD3: CONTAINMENT

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. SUPPORT FACILITIES							
1. Office Trailer	1		Included in installation cost		$14,400.00	$14,400.00	$14,400.00
2. Decontamination Trailer	1				$28,200.00	$28,200.00	$28,200.00
II. SOIL COVER							
1. Dredging	43,500	cy			$17.55	$763,425.00	$763,425.00
2. Sandy Loam Fill	43,500	cy			$14.00	$609,000.00	$609,000.00
3. Vegetation	87,000	sq. yd.			$0.64	$55,680.00	$55,680.00
4. Dewater Sediment	43,500	cy			$1.60	$69,600.00	$69,600.00
5. On-site Disposal	43,500	cy			$12.00	$522,000.00	$522,000.00
6. Treatment and Disposal of Wastewater	5,452,920	gallon			$0.13	$708,879.60	$708,879.60
III. INSTITUTIONAL CONTROLS							
1. Land Use Restrictions	1	LS			$15,100.00	$15,100.00	$15,100.00
IV. MOBILIZATION/DEMOBILIZATION	1	LS			$66,500.00	$66,500.00	$66,500.00
V. HEALTH AND SAFETY	1	LS			$160,000.00	$160,000.00	$160,000.00

Total Direct Construction Cost (TDCC)	$3,012,784.60
Contingency @ 20% of TDCC	$602,556.92
Engineering and Construction Management @ 15% of TDCC	$451,917.69
Legal and Administration @ 5% of TDCC	$150,639.23
Total Construction Cost	$4,217,898.44

400367

TABLE C-22

ALTERNATIVE SD3: CONTAINMENT

OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
	1. Sediment and Surface Water Sampling	2 persons @ $60/hr - 50 hrs/yr, ODCs for sampling equipments @ $5,000 per/yr.	$11,000.00	1 - 30
	2. Monitoring of Sediment (e.g., sediment cover)	1 person @ $60/hr - 8 hrs/yr, ODCs for travel, safety supplies @ $100 per/yr.	$1,060.00	1 - 30
	3. Laboratory Analysis	Analysis & validation of 6 water samples @ $1,200/ sample and 8 sediment samples @ $2,500/sample.	$27,200.00	1 - 30
	4. Report	1 person @ $80/hr - 80hrs/yr	$6,400.00	1 - 30
II.	MAINTENANCE	1% of capital cost (except for dredging, dewatering, and disposal of sediments and wastewater and Land Use Restrictions)*	$13,072.92	1 - 30
III.	CONTINGENCY	5% of annual O&M cost 10% of capital cost incurred in year 3**	$2,936.65 $130,729.20	1 - 30 3
	Total Annual O&M		$61,669.57	
	Present Worth of O&M (excl. reviews)	For 30 year O&M, @7% discount rate	$871,971.61	
IV.	FIVE-YEAR REVIEWS	$25,000 per review	$25,000.00	5, 10, 15, 20, 25,
	Present Worth of Reviews	For every 5 year, @7% discount rate	$53,900.00	
	Total Present Worth of O&M		$925,871.61	

* Typical annual maintenance costs for a passive remedy are estimated to be 1% of the capital cost of the remedy, excluding removal/ disposal costs and Land Use Restrictions. Maintenance costs for this alternative include general cap maintenance, such as regrading/ revegetating up to ~2 acres. Costs for replacement of any failed component of the remedy or any other upgrades are not included.

** A one time cost of 10% of the capital cost, excluding removal/off-site disposal and Land Use Restrictions, is estimated for year 3, as a contingency for failure of a component of the remedy.

TABLE C-23

ALTERNATIVE SD4: DREDGING/DEWATERING/OFF-SITE DISPOSAL

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. SUPPORT FACILITIES							
1. Office Trailer	1		Included in installation cost		$14,400.00	$14,400.00	$14,400.00
2. Decontamination Trailer	1				$28,200.00	$28,200.00	$28,200.00
II. SOIL COVER							
1. Dredging	116,000	cy			$17.55	$2,035,800.00	$2,035,800.00
2. Sandy Loam Fill	43,500	cy			$14.00	$609,000.00	$609,000.00
3. Sediment Fill	72,500	cy			$14.00	$1,015,000.00	$1,015,000.00
4. Vegetation	87,000	sq. yd.			$0.64	$55,680.00	$55,680.00
5. Dewater Sediment	116,000	cy			$1.60	$185,600.00	$185,600.00
6. Off-site Disposal	116,000	cy			$60.80	$7,052,800.00	$7,052,800.00
7. Treatment and Disposal of Wastewater	13,900,000	gallon			$0.13	$1,807,000.00	$1,807,000.00
III. MOBILIZATION/DEMOBILIZATION	1	LS			$66,500.00	$66,500.00	$66,500.00
IV. HEALTH AND SAFETY	1	LS			$240,000.00	$240,000.00	$240,000.00
V. SHORT-TERM MAINTENANCE (contingency)							
1. Sediment Monitoring	3	yr			$1,060.00	$3,180.00	$3,180.00
2. Maintenance	3	yr			$219,108.24	$657,324.72	$657,324.72
		Total Direct Construction Cost (TDCC)					$13,770,484.72
		Contingency @ 20% of TDCC					$2,754,096.94
		Engineering and Construction Management @ 15% of TDCC					$2,065,572.71
		Legal and Administration @ 5% of TDCC					$688,524.24
		Total Construction Cost					$19,278,678.61

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400369

TABLE C-24

ALTERNATIVE SD4: DREDGING/DEWATERING/OFF-SITE DISPOSAL

OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM	BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR

Source removed and no operation and maintenance cost anticipated.

400370

TABLE C-25

ALTERNATIVE SD5: DREDGING/DEWATERING/ON-SITE DISPOSAL

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. SUPPORT FACILITIES							
1. Office Trailer	1		Included in installation cost		$14,400.00	$14,400.00	$14,400.00
2. Decontamination Trailer	1				$28,200.00	$28,200.00	$28,200.00
II. SOIL COVER							
1. Dredging	116,000	cy			$17.55	$2,035,800.00	$2,035,800.00
2. Sandy Loam Fill	43,500	cy			$14.00	$609,000.00	$609,000.00
3. Sediment Fill	72,500	cy			$14.00	$1,015,000.00	$1,015,000.00
4. Vegetation	87,000	sq. yd.			$0.64	$55,680.00	$55,680.00
5. Dewater Sediment	116,000	cy			$1.60	$185,600.00	$185,600.00
6. On-site Disposal	116,000	cy			$12.00	$1,392,000.00	$1,392,000.00
7. Treatment and Disposal of Wastewater	13,900,000	gallon			$0.13	$1,807,000.00	$1,807,000.00
III. MOBILIZATION/DEMOBILIZATION	1	LS			$66,500.00	$66,500.00	$66,500.00
IV. HEALTH AND SAFETY	1	LS			$240,000.00	$240,000.00	$240,000.00
V. SHORT-TERM MAINTENANCE (contingency)							
1. Sediment Monitoring	3	yr			$1,060.00	$3,180.00	$3,180.00
2. Maintenance	3	yr			$219,108.24	$657,324.72	$657,324.72
		Total Direct Construction Cost (TDCC)					$8,109,684.72
		Contingency @ 20% of TDCC					$1,621,936.94
		Engineering and Construction Management @ 15% of TDCC					$1,216,452.71
		Legal and Administration @ 5% of TDCC					$405,484.24
		Total Construction Cost					$11,353,558.61

400371

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TABLE C-26

ALTERNATIVE SD5: DREDGING/DEWATERING/ON-SITE DISPOSAL

OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM	BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR

Source removed and no operation and maintenance cost anticipated.

400372

TABLE C-27

ALTERNATIVE GW1: NO ACTION

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
No Remedial Action							

TABLE C-28

ALTERNATIVE GW1: NO ACTION

ANNUAL OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	FIVE YEAR REVIEWS	$25,000 per review	$25,000.00	5, 10, 15, 20, 25, 30
	Total Worth of Reviews	For every 5 year, @7% discount rate	$53,900.00	
	Total Present Worth of O&M		$53,900.00	

400374

TABLE C-29

ALTERNATIVE GW2: LIMITED ACTION

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. GROUNDWATER USE RESTRICTIONS	1	LS	Included in installation cost		$10,700.00	$10,700.00	$10,700.00

Total Direct Construction Cost (TDCC)	$10,700.00
Contingency @ 20% of TDCC	$2,140.00
Engineering and Construction Management @ 15% of TDCC	$1,605.00
Legal and Administration @ 5% of TDCC	$535.00
Total Construction Cost	$14,980.00

400375

TABLE C-30

ALTERNATIVE GW2: LIMITED ACTION

ANNUAL OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
	1. Water Sampling	2 persons @ $60/hr - 100 hrs/yr, ODCs	$17,000.00	1 - 30
	2. Water Laboratory Analysis	20 water sample analysis & validation	$24,000.00	1 - 30
	3. Report	1 person @ $80/hr - 80hrs/yr	$6,400.00	1 - 30
II.	MAINTENANCE	8% of capital cost (excluding Groundwater Use Restrictions)*	$0.00	1 - 30
III.	CONTINGENCY	5% of annual O&M cost**	$2,370.00	1 - 30
	Total Annual O&M		$49,770.00	
	Present Worth of O&M (excl. reviews)	For 30 year O&M, @7% discount rate	$617,595.93	
IV.	FIVE YEAR REVIEWS	$25,000 per review	$25,000.00	5, 10, 15, 20, 25, 30
	Total Worth of Reviews	For every 5 year, @7% discount rate	$53,900.00	
	Total Present Worth of O&M		$671,495.93	

* No maintenance costs are estimated for this alternative, since only administrative actions are taken.

**No additional contingency costs for system component failures are estimated, since no mechanical systems would be installed in this alternative.

400376

TABLE C-31

ALTERNATIVE GW3: CONTAINMENT VIA BARRIER WALLS

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. SUPPORT FACILITIES							
1. Office Trailer	1		Included in installation cost		$14,400.00	$14,400.00	$14,400.00
2. Decontamination Trailer	1		Included in installation cost		$28,200.00	$28,200.00	$28,200.00
II. BARRIER WALLS	132,600	sq. ft.	Included in installation cost		$25.00	$3,315,000.00	$3,315,000.00
III. GROUNDWATER EXTRACTION							
1. Extraction Wells	7		$650.00	$4,550.00	$7,900.00	$55,300.00	$59,850.00
2. Pumps	7		Included in installation cost		$14,600.00	$102,200.00	$102,200.00
3. Piping	500	ft.	$5.25	$2,625.00	$30.00	$15,000.00	$17,625.00
	2,500	ft.	$10.00	$25,000.00	$58.00	$145,000.00	$170,000.00
4. Pilot Pump Test	1		Included in installation cost		$50,000.00	$50,000.00	$50,000.00
IV. COLLECTION/EQUALIZATION TANK							
1. Collection Tank	1		$12,600.00	$12,600.00	$2,900.00	$2,900.00	$15,500.00
2. Pumps	2		$3,700.00	$7,400.00	$4,300.00	$8,600.00	$16,000.00
3. Piping	50	ft.	$10.00	$500.00	$33.00	$1,650.00	$2,150.00
V. CHEMICAL PRECIPITATION SYSTEM							
1. Rapid Mix Tank	1		$3,000.00	$3,000.00	$2,000.00	$2,000.00	$5,000.00
2. Flocculator	1		Included in Clarifier Cost				$0.00
3. Clarifier	1		$62,000.00	$62,000.00	Included in material cost		$62,000.00

TABLE C-31

ALTERNATIVE GW3: CONTAINMENT VIA BARRIER WALLS

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
4. Caustic Feed Tank	1		$3,600.00	$3,600.00	$1,050.00	$1,050.00	$4,650.00
5. Caustic Feed Pumps	2		$950.00	$1,900.00	$3,900.00	$7,800.00	$9,700.00
6. Ferric Chloride Feed Tank	1		$3,600.00	$3,600.00	$1,050.00	$1,050.00	$4,650.00
7. Ferric Chloride Feed Pumps	2		$950.00	$1,900.00	$3,900.00	$7,800.00	$9,700.00
8. Polymer Feed Tank	1		$1,400.00	$1,400.00	$1,050.00	$1,050.00	$2,450.00
9. Polymer Feed Pumps	2		$950.00	$1,900.00	$3,900.00	$7,800.00	$9,700.00
10. Sulfuric Acid Feed Tank	1		$2,375.00	$2,375.00	$1,050.00	$1,050.00	$3,425.00
11. Sulfuric Acid Feed Pumps	2		$950.00	$1,900.00	$3,900.00	$7,800.00	$9,700.00
12. Process Piping	50	ft.	$10.00	$500.00	$33.00	$1,650.00	$2,150.00
	200	ft.	$5.25	$1,050.00	$17.00	$3,400.00	$4,450.00
VI. FILTRATION SYSTEM							
1. Filter Feed Water Sump	1		$9,700.00	$9,700.00	$2,800.00	$2,800.00	$12,500.00
2. Filter Feed Pumps	2		$3,700.00	$7,400.00	$4,300.00	$8,600.00	$16,000.00
3. Process Piping	50	ft.	$10.00	$500.00	$33.00	$1,650.00	$2,150.00
4. Dual Media Pressure Filters	2		$53,500.00	$107,000.00	$7,000.00	$14,000.00	$121,000.00
VII. SLUDGE HANDLING SYSTEM							
1. Clarifier Sludge Pumps	2		$1,300.00	$2,600.00	$1,700.00	$3,400.00	$6,000.00
2. Sludge Thickener Tank	1		$6,900.00	$6,900.00	$1,600.00	$1,600.00	$8,500.00

400378

TABLE C-31

ALTERNATIVE GW3: CONTAINMENT VIA BARRIER WALLS

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION		ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
	3. Filter Press	1		$44,500.00	$44,500.00	$8,300.00	$8,300.00	$52,800.00
	4. Filtrate Pumps	2		$2,500.00	$5,000.00	$4,200.00	$8,400.00	$13,400.00
	5. Process Piping	200	ft.	$10.00	$2,000.00	$33.00	$6,600.00	$8,600.00
VIII.	LIQUID PHASE CARBON							
	1. Activated Carbon Adsorber	1		$8,500.00	$8,500.00	Included in installation cost		$8,500.00
	2. Process Piping	50	ft.	$10.00	$500.00	$33.00	$1,650.00	$2,150.00
IX.	DISCHARGE SYSTEM							
	1. Treated Water Holding Tank	1		$2,100.00	$2,100.00	$5,800.00	$5,800.00	$7,900.00
	2. Treated Water Discharge Pumps	2		$3,700.00	$7,400.00	$4,300.00	$8,600.00	$16,000.00
	3. Piping	600	ft.	$10.00	$6,000.00	$58.00	$34,800.00	$40,800.00
	4. Outfall Structure	1		$3,300.00	$3,300.00	$6,600.00	$6,600.00	$9,900.00
X.	ELECTRICALS	1	LS	$115,000.00	$115,000.00	$121,700.00	$121,700.00	$236,700.00
XI.	INSTRUMENTATION AND CONTROLS	1	LS	$173,000.00	$173,000.00	$72,200.00	$72,200.00	$245,200.00
XII.	UTILITIES (Water, Phones, etc.)	1	LS	$34,200.00	$34,200.00	$72,200.00	$72,200.00	$106,400.00
XIII.	FOUNDATIONS, PADS AND	1	LS	$78,900.00	$78,900.00	$101,700.00	$101,700.00	$180,600.00

400379

TABLE C-31

ALTERNATIVE GW3: CONTAINMENT VIA BARRIER WALLS

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
XIV. INSTITUTIONAL CONTROLS							
1. Water Use Restrictions	1	LS	Included in installation cost		$10,700.00	$10,700.00	$10,700.00
XV. HEALTH AND SAFETY	1	LS	Included in installation cost		$85,500.00	$85,500.00	$85,500.00
XVI. MOBILIZATION/DEMOBILIZATION	1	LS	Included in installation cost		$47,500.00	$47,500.00	$47,500.00

Total Direct Construction Cost (TDCC)	$5,157,300.00
Contingency @ 20% of TDCC	$1,031,460.00
Engineering and Construction Management @ 15% of TDCC	$773,595.00
Legal and Administration @ 5% of TDCC	$257,865.00
Total Construction Cost	$7,220,220.00

400380

TABLE C-32

ALTERNATIVE GW3: CONTAINMENT VIA BARRIER WALLS

ANNUAL OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
	1. Water Sampling	2 persons @ $60/hr - 100 hrs/yr, ODCs for sampling equipment @ $5,000 per/yr.	$17,000.00	1 - 30
	2. Water Laboratory Analysis	20 water sample analysis & validation @ 1200/sample	$24,000.00	1 - 30
	3. Report	1 person @ $80/hr - 80hrs/yr	$6,400.00	1 - 30
II.	PERFORMANCE MONITORING			
	1. Labor	Plant operator will perform		
	2. Laboratory Analysis	4 water samples/month @ 1,200/sample	$57,600.00	1 - 30
III.	GROUNDWATER EXTRACTION			
	1. Power for 7- 11 gpm pumps	0.5 HP pump, 7 pumps, @ $ 0.125/KWH	$2,859.05	1 - 30
IV.	COLLECTION/EQUALIZATION TANK			
	1. Power for 77 gpm pump	2.0 HP pump, @ $ 0.125/KWH	$1,633.74	1 - 30
V.	CHEMICAL PRECIPITATION SYSTEM			
	1. Power for Rapid Mix Tank	0.5 HP motor, @ $ 0.125/KWH	$408.44	1 - 30

400381

TABLE C-32

ALTERNATIVE GW3: CONTAINMENT VIA BARRIER WALLS

ANNUAL OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
	2. Power for Flocculator	1.0 HP motor, @ $ 0.125/KWH	$816.87	1 - 30
	3. Power for Caustic Feed Pumps	0.25 HP pump, @ $ 0.125/KWH	$204.22	1 - 30
	4. Power for Ferric Chloride Feed Pumps	0.25 HP pump, @ $ 0.125/KWH	$204.22	1 - 30
	5. Power for Polymer Feed Pumps	0.25 HP pump, @ $ 0.125/KWH	$204.22	1 - 30
	6. Caustic Usage	4.2 ton/yr @ $700/ton	$2,940.00	1 - 30
	7. Ferric Chloride Usage	10.5 ton/yr @ $400/ton	$4,200.00	1 - 30
	8. Polymer Usage	0.8 ton/yr @ $5,200/ton	$4,160.00	1 - 30
	9. Sulfuric Acid Usage	10.5 ton/yr @ $1,050/ton	$11,025.00	1 - 30
VI.	FILTRATION SYSTEM			
	1. Power for Filter Feed Pumps	2.0 HP pump, @ $ 0.125/KWH	$1,633.74	1 - 30
	2. Power for Backwash Pump	4.0 HP pump, @ $ 0.125/KWH	$3,267.48	1 - 30
VII.	SLUDGE HANDLING SYSTEM			
	1. Power for Clarifier Sludge Pumps	0.75 HP pump, @ $ 0.125/KWH	$612.65	1 - 30

TABLE C-32

ALTERNATIVE GW3: CONTAINMENT VIA BARRIER WALLS

ANNUAL OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
	2. Power for Filter Press Feed Pumps	0.75 HP pump, @ $ 0.125/KWH	$612.65	1 - 30
	3. Power for Filter Press	5.0 HP pump, @ $ 0.125/KWH	$4,084.35	1 - 30
	4. Filtrate Pumps	0.75 HP pump, @ $ 0.125/KWH	$612.65	1 - 30
	5. Off-Site Sludge Disposal	84 ton/yr @ $290/ton	$24,360.00	1 - 30
VIII.	LIQUID PHASE CARBON ADSORPTION SYSTEM			
	1. Liquid Phase Carbon Replace and Disposal	1,000 lbs/3month, $3/lb	$12,000.00	1 - 30
IX.	DISCHARGE SYSTEM			
	1. Power for Discharge Pumps	2.0 HP pump, @ $ 0.125/KWH	$1,633.74	1 - 30
	2. Power for Misc. equipment/Instrument	15 KWH, @$0.125/KWH	$16,425.00	1 - 30
	3. Power for Lighting	15 KWH, @$0.125/KWH	$16,425.00	1 - 30
X.	LABOR	1 Operator @ 70/hr, 8hr/day, 365 days/yr	$204,400.00	1 - 30

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TABLE C-32

ALTERNATIVE GW3: CONTAINMENT VIA BARRIER WALLS

ANNUAL OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
XI.	MAINTENANCE	8% of capital cost excluding barrier wall*	$206,337.60	1 - 30
XII.	CONTINGENCY	5% of annual O&M cost**	$31,303.03	1 - 30
	Total Annual O&M		$657,363.64	
	Present Worth of O&M (excl. reviews)	For 30 year O&M, @7% discount rate	$8,157,225.41	
XIII.	FIVE YEAR REVIEWS	$25,000 per review	$25,000.00	5, 10, 15, 20, 25,
	Total Worth of Reviews	For every 5 year, @7% discount rate	$53,900.00	
	Total Present Worth of O&M		$8,211,125.41	

* Typical annual maintenance costs for an active groundwater remedy are estimated to be 8% of the capital cost of the remedy, excluding costs for the barrier wall, which would have a design life of 30 years. These maintenance costs include costs for equipment repairs and replacements anticipated for the mechanical components associated with the groundwater treatment system (i.e., contingency for system component failures are included on an annual basis).

**No additional contingency costs for system component failures are estimated, since contingency costs for repair or replacement of mechanical systems are included in the annual maintenance cost.

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TABLE C-33

ALTERNATIVE GW4: RESTORATION (EXTRACTION WELLS FOR PUMP-AND-TREAT)

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
I. SUPPORT FACILITIES							
1. Office Trailer	1		Included in installation cost		$14,400.00	$14,400.00	$14,400.00
2. Decontamination Trailer	1		Included in installation cost		$28,200.00	$28,200.00	$28,200.00
II. GROUNDWATER EXTRACTION							
1. Extraction Wells	2		$800.00	$1,600.00	$9,600.00	$19,200.00	$20,800.00
	3		$800.00	$2,400.00	$9,600.00	$28,800.00	$31,200.00
	3		$950.00	$2,850.00	$11,500.00	$34,500.00	$37,350.00
	3		$200.00	$600.00	$2,300.00	$6,900.00	$7,500.00
	1		$400.00	$400.00	$4,500.00	$4,500.00	$4,900.00
	3		$310.00	$930.00	$3,700.00	$11,100.00	$12,030.00
2. Pumps	2		Included in installation cost		$12,100.00	$24,200.00	$24,200.00
	3		Included in installation cost		$14,600.00	$43,800.00	$43,800.00
	3		Included in installation cost		$14,600.00	$43,800.00	$43,800.00
	3		Included in installation cost		$5,600.00	$16,800.00	$16,800.00
	1		Included in installation cost		$5,600.00	$5,600.00	$5,600.00
	3		Included in installation cost		$9,600.00	$28,800.00	$28,800.00
3. Piping	500	ft.	$5.25	$2,625.00	$30.00	$15,000.00	$17,625.00
	2,500	ft.	$8.00	$20,000.00	$46.00	$115,000.00	$135,000.00
	500	ft.	$5.25	$2,625.00	$30.00	$15,000.00	$17,625.00
	2,500	ft.	$8.00	$20,000.00	$46.00	$115,000.00	$135,000.00

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TABLE C-33

ALTERNATIVE GW4: RESTORATION (EXTRACTION WELLS FOR PUMP-AND-TREAT)

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
	1,000	ft.	$5.25	$5,250.00	$30.00	$30,000.00	$35,250.00
	2,500	ft.	$8.00	$20,000.00	$46.00	$115,000.00	$135,000.00
4. Pilot Pump Test	1		Included in installation cost		$50,000.00	$50,000.00	$50,000.00
III. COLLECTION/EQUALIZATION TANK							
1. Collection Tank	1		$14,800.00	$14,800.00	$3,400.00	$3,400.00	$18,200.00
2. Pumps	2		$4,400.00	$8,800.00	$5,100.00	$10,200.00	$19,000.00
3. Piping	50	ft.	$10.00	$500.00	$33.00	$1,650.00	$2,150.00
IV. CHEMICAL PRECIPITATION SYSTEM							
1. Rapid Mix Tank	1		$3,400.00	$3,400.00	$2,250.00	$2,250.00	$5,650.00
2. Flocculator	1		Included in Clarifier Cost			$0.00	$0.00
3. Clarifier	1		$73,000.00	$73,000.00	Included in material Cost		$73,000.00
4. Caustic Feed Tank	1		$3,800.00	$3,800.00	$1,150.00	$1,150.00	$4,950.00
5. Caustic Feed Pumps	2		$950.00	$1,900.00	$3,900.00	$7,800.00	$9,700.00
6. Ferric Chloride Feed Tank	1		$3,800.00	$3,800.00	$1,150.00	$1,150.00	$4,950.00
7. Ferric Chloride Feed Pumps	2		$950.00	$1,900.00	$3,900.00	$7,800.00	$9,700.00
8. Polymer Feed Tank	1		$2,200.00	$2,200.00	$1,150.00	$1,150.00	$3,350.00
9. Polymer Feed Pumps	2		$950.00	$1,900.00	$3,900.00	$7,800.00	$9,700.00
10. Sulfuric Acid Feed Tank	1		$2,500.00	$2,500.00	$1,150.00	$1,150.00	$3,650.00
11. Sulfuric Acid Feed Pumps	2		$950.00	$1,900.00	$3,900.00	$7,800.00	$9,700.00
12. Process Piping	50	ft.	$10.00	$500.00	$33.00	$1,650.00	$2,150.00

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TABLE C-33

ALTERNATIVE GW4: RESTORATION (EXTRACTION WELLS FOR PUMP-AND-TREAT)

CAPITAL COST ESTIMATES (2002 DOLLARS)

FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
	100	ft.	$5.25	$525.00	$17.00	$1,700.00	$2,225.00
V. FILTRATION SYSTEM							
1. Filter Feed Water Sump	1		$11,000.00	$11,000.00	$3,200.00	$3,200.00	$14,200.00
2. Filter Feed Pumps	2		$4,400.00	$8,800.00	$5,100.00	$10,200.00	$19,000.00
3. Process Piping	50	ft.	$10.00	$500.00	$33.00	$1,650.00	$2,150.00
4. Dual Media Pressure Filters	2		$63,300.00	$126,600.00	$8,300.00	$16,600.00	$143,200.00
VI. SLUDGE HANDLING SYSTEM							
1. Clarifier Sludge Pumps	2		$1,500.00	$3,000.00	$2,000.00	$4,000.00	$7,000.00
2. Sludge Thickener Tank	1		$8,000.00	$8,000.00	$1,900.00	$1,900.00	$9,900.00
3. Filter Press	1		$48,900.00	$48,900.00	$9,100.00	$9,100.00	$58,000.00
4. Filtrate Pumps	2		$2,800.00	$5,600.00	$4,800.00	$9,600.00	$15,200.00
5. Process Piping	200	ft.	$10.00	$2,000.00	$33.00	$6,600.00	$8,600.00
VII. LIQUID PHASE CARBON ADSORPTION SYSTEM							
1. Activated Carbon Adsorber	1		$8,500.00	$8,500.00	Included in material cost		$8,500.00
2. Process Piping	50	ft.	$10.00	$500.00	$33.00	$1,650.00	$2,150.00
VIII. DISCHARGE SYSTEM							
1. Treated Water Holding Tank	1		$1,900.00	$1,900.00	$5,100.00	$5,100.00	$7,000.00
2. Treated Water Discharge Pumps	2		$4,400.00	$8,800.00	$5,100.00	$10,200.00	$19,000.00
3. Piping	600	ft.	$10.00	$6,000.00	$58.00	$34,800.00	$40,800.00
4. Outfall Structure	1		$3,900.00	$3,900.00	$7,800.00	$7,800.00	$11,700.00
IX. ELECTRICALS	1	LS	$136,000.00	$136,000.00	$144,000.00	$144,000.00	$280,000.00

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TABLE C-33

ALTERNATIVE GW4: RESTORATION (EXTRACTION WELLS FOR PUMP-AND-TREAT)

CAPITAL COST ESTIMATES (2002 DOLLARS)

	FACILITY/CONSTRUCTION	ESTIMATED QUANTITIES	UNITS	MATERIAL UNIT PRICE	MATERIAL COST	INSTALLATION UNIT PRICE	INSTALLATION COST	DIRECT CONSTRUCTION COST
X.	INSTRUMENTATION AND CONTROLS	1	LS	$204,800.00	$204,800.00	$85,500.00	$85,500.00	$290,300.00
XI.	UTILITIES (Water, Phones, etc.)	1	LS	$40,500.00	$40,500.00	$85,500.00	$85,500.00	$126,000.00
XII.	FOUNDATIONS, PADS AND	1	LS	$93,400.00	$93,400.00	$120,400.00	$120,400.00	$213,800.00
XIII.	INSTITUTIONAL CONTROLS							
	1. Water Use Restrictions	1	LS	Included in installation cost		$10,700.00	$10,700.00	$10,700.00
XIV.	HEALTH AND SAFETY	1	LS	Included in installation cost		$101,300.00	$101,300.00	$101,300.00
XV.	MOBILIZATION/DEMOBILIZATION	1	LS	Included in installation cost		$56,300.00	$56,300.00	$56,300.00
				Total Direct Construction Cost (TDCC)				$2,467,755.00
				Contingency @ 20% of TDCC				$493,551.00
				Engineering and Construction Management @ 15% of TDCC				$370,163.25
				Legal and Administration @ 5% of TDCC				$123,387.75
				Total Construction Cost				$3,454,857.00

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TABLE C-34

ALTERNATIVE GW4: RESTORATION (EXTRACTION WELLS FOR PUMP-AND-TREAT)

ANNUAL OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
	1. Water Sampling	2 persons @ $60/hr - 100 hrs/yr, ODCs for sampling equipment @ $5,000 per/yr.	$17,000.00	1 - 30
	2. Water Laboratory Analysis	20 water sample analysis & validation @ 1,200/ sample	$24,000.00	1 - 30
	3. Report	1 person @ $80/hr - 80hrs/yr	$6,400.00	1 - 30
II.	PERFORMANCE MONITORING			
	1. Labor	Plant operator will perform		
	2. Laboratory Analysis	4 water samples/month @ 1,200/sample	$57,600.00	1 - 30
III.	GROUNDWATER EXTRACTION			
	1. Power for 15 pumps	(7 X 0.25, 2 X 0.5, 6 X 1) 8.75 HP pumps, @ $ 0.125/KWH	$7,147.61	1 - 30
IV.	COLLECTION/EQUALIZATION TANK			
	1. Power for 102 gpm pump	3.0 HP pump, @ $ 0.125/KWH	$2,450.61	1 - 30
V.	CHEMICAL PRECIPITATION SYSTEM			

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TABLE C-34

ALTERNATIVE GW4: RESTORATION (EXTRACTION WELLS FOR PUMP-AND-TREAT)

ANNUAL OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
	1. Power for Rapid Mix Tank	0.5 HP motor, @ $ 0.125/KWH	$408.44	1 - 30
	2. Power for Flocculator	1.0 HP motor, @ $ 0.125/KWH	$816.87	1 - 30
	3. Power for Caustic Feed Pumps	0.25 HP pump, @ $ 0.125/KWH	$204.22	1 - 30
	4. Power for Ferric Chloride Feed Pumps	0.25 HP pump, @ $ 0.125/KWH	$204.22	1 - 30
	5. Power for Polymer Feed Pumps	0.25 HP pump, @ $ 0.125/KWH	$204.22	1 - 30
	6. Caustic Usage	5.5 ton/yr @ $700/ton	$3,850.00	1 - 30
	7. Ferric Chloride Usage	14 ton/yr @ $400/ton	$5,600.00	1 - 30
	8. Polymer Usage	1.1 ton/yr @ $5,200/ton	$5,720.00	1 - 30
	9. Sulfuric Acid Usage	14 ton/yr @ $1,050/ton	$14,700.00	1 - 30
VI.	FILTRATION SYSTEM			
	1. Power for Filter Feed Pumps	3.0 HP pump, @ $ 0.125/KWH	$2,450.61	1 - 30
	2. Power for Backwash Pump	5.0 HP pump, @ $ 0.125/KWH	$4,084.35	1 - 30
VII.	SLUDGE HANDLING SYSTEM			

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TABLE C-34

ALTERNATIVE GW4: RESTORATION (EXTRACTION WELLS FOR PUMP-AND-TREAT)

ANNUAL OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
	1. Power for Clarifier Sludge Pumps	1.0 HP pump, @ $ 0.125/KWH	$816.87	1 - 30
	2. Power for Filter Press Feed Pumps	1.0 HP pump, @ $ 0.125/KWH	$816.87	1 - 30
	3. Power for Filter Press	6.0 HP pump, @ $ 0.125/KWH	$4,901.22	1 - 30
	4. Filtrate Pumps	1.0 HP pump, @ $ 0.125/KWH	$816.87	1 - 30
	5. Off-Site Sludge Disposal	112 ton/yr @ $290/ton	$32,480.00	1 - 30
VIII.	LIQUID PHASE CARBON ADSORPTION SYSTEM			
	1. Liquid Phase Carbon Replace and Disposal	1,000 lbs/3month, $3/lb	$12,000.00	1 - 30
IX.	DISCHARGE SYSTEM			
	1. Power for Discharge Pumps	3.0 HP pump, @ $ 0.125/KWH	$2,450.61	1 - 30
	2. Power for Misc. equipment/Instrument	20 KWH, @$0.125/KWH	$21,900.00	1 - 30
	3. Power for Lighting	20 KWH, @$0.125/KWH	$21,900.00	1 - 30
X.	LABOR	1 Operator @ 70/hr, 8hr/day, 365 days/yr	$204,400.00	1 - 30

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TABLE C-34

ALTERNATIVE GW4: RESTORATION (EXTRACTION WELLS FOR PUMP-AND-TREAT)

ANNUAL OPERATION AND MAINTENANCE COST ESTIMATES (2002 DOLLARS)

ITEM		BASIS OF ESTIMATE	ANNUAL O&M COST ESTIMATE	YEAR
I.	EFFECTIVENESS MONITORING			
XI.	MAINTENANCE	8% of capital cost*	$276,388.56	1 - 30
XII.	CONTINGENCY	5% of annual O&M cost**	$36,585.61	1 - 30
	Total Annual O&M		$768,297.75	
	Present Worth of O&M (excl. reviews)	For 30 year O&M, @7% discount rate	$9,533,806.74	
XIII.	FIVE YEAR REVIEWS	$25,000 per review	$25,000.00	5, 10, 15, 20, 25, 30
	Total Worth of Reviews	For every 5 year, @7% discount rate	$53,900.00	
	Total Present Worth of O&M		$9,587,706.74	

* Typical annual maintenance costs for an active groundwater remedy are estimated to be 8% of the capital cost of the remedy. These maintenance costs include costs for equipment repairs and replacements anticipated for the mechanical components associated with the groundwater treatment system (i.e., contingency for system component failures are included on an annual basis).

**No additional contingency costs for system component failures are estimated, since contingency costs for repair or replacement of mechanical systems are included in the annual maintenance cost.

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TABLE C-35

MAIN PLANT/SLAG DISPOSAL AREA COST ALLOCATION SUMMARY (2002 DOLLARS)

ALTERNATIVE	MAIN PLANT AREA				SLAG DISPOSAL AREA				GRAND TOTAL (ENTIRE SITE)			
	CAPITAL COST	ANNUAL O&M	PW OF O&M	TOTAL PW	CAPITAL COST	ANNUAL O&M	PW OF O&M	TOTAL PW	CAPITAL COST	ANNUAL O&M	PW OF O&M	TOTAL PW
SL1: NO ACTION *	$0	$0	$42,152	$42,152	$0	$0	$11,748	$11,748	$0	$0	$53,900	$53,900
SL2: LIMITED ACTION *	$1,353,626	$248,662	$3,236,146	$4,589,772	$377,280	$69,307	$901,972	$1,279,252	$1,730,906	$317,968	$4,138,118	$5,869,024
SL3: CONTAINMENT - OPTION (A) *	$14,136,133	$166,117	$3,386,118	$17,522,251	$5,955,995	$46,300	$943,772	$6,899,767	$20,092,128	$212,416	$4,329,891	$24,422,019
SL3: CONTAINMENT - OPTION (B) *	$11,592,063	$139,404	$2,846,968	$14,439,031	$5,246,917	$38,854	$793,501	$6,040,418	$16,838,980	$178,258	$3,640,469	$20,479,449
SL4: SOURCE REMOVAL/OFF-SITE DISPOSAL **	$355,095,210	$0	$0	$355,095,210	$294,835,511	$0	$0	$294,835,511	$649,930,721	$0	$0	$649,930,721
SL5: EXCAVATION/SOIL WASHING/ON-SITE BACKFILL **	$150,327,086	$0	$0	$150,327,086	$125,979,102	$0	$0	$125,979,102	$276,306,188	$0	$0	$276,306,188
SL6: IN SITU STABILIZATION/CONTAINMENT - OPTION (A) **	$61,905,517	$98,934	$2,020,188	$63,925,705	$53,064,684	$81,584	$1,665,892	$54,730,576	$114,970,201	$180,518	$3,686,080	$118,656,281
SL6: IN SITU STABILIZATION/CONTAINMENT - OPTION (B) **	$61,160,264	$91,109	$1,862,251	$63,022,515	$52,450,132	$75,131	$1,535,654	$53,985,786	$113,610,396	$166,240	$3,397,904	$117,008,300

Note:

* - Cost allocation for main plant and slag disposal area is based on area of contamination (except for Slag Area Riprap Capital Costs).

** - Cost allocation for main plant and slag disposal area is based on volume of contamination (except for Slag Area Riprap Capital Costs).

Annual O&M = Estimate annual expenditures for normal maintenance activities (excludes Year 3 Contingency and 5-year reviews)

PW of O&M= Present Worth of Annual O&M, Year 3 Contingency and 5-year reviews

Total PW=Capital Cost + PW of O&M

APPENDIX D

TECHNICAL MEMORANDUM - RESULTS OF GROUNDWATER MODELING

FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

TO: Roebling Steel Company Site
Project File

DATE: March 15, 2002

FROM: Gordon Jamieson and David Li

SUBJECT: USEPA RAC II Contract Number: 68-W-98-214
Work Assignment Number: 001-RICO-0291
Roebling Steel Company Site
Technical Memorandum
Results of Groundwater Modeling

This memo and attached figures present the results of groundwater modeling for the Roebling Steel Company Site (RSC). The computer code used for this modeling effort was the Department of Defense Groundwater Modeling System (GMS). The most recent version 3.1 was used for the groundwater flow and metals transport modeling. For this modeling effort, the following specific GMS modules and models were utilized:

- GMS graphical user interface;
- GMS map module for model conceptualization and dataset presentation;
- USGS MODFLOW 96 3D groundwater flow code;
- USGS MODPATH 96 3D particle tracking code; and
- MT3DMS (Release DoD_3.50.A) 3D multi-species transport code.

The modeling was performed in a three-step process that included:

1) Development of a calibrated steady-state groundwater flow model for the RSC.
2) Development of a transient contaminant transport model for the RSC.
3) Simulation of various groundwater remediation scenarios using the transport model.

Edward Modica and Tamara Rossi of the USEPA reviewed our work as each step of the modeling was performed and provided valuable comments and approvals throughout the process. This was accomplished with one meeting, three conference calls and four technical memos dated February 12, February 15, February 28, and March 11, 2002.

The information below includes the results of the three steps discussed above and conclusions for the various groundwater remediation scenarios.

CALIBRATED GROUNDWATER FLOW MODEL

The process of the model development is discussed below and includes the development of the conceptual and numerical models; model boundary conditions; model calibration and model sensitivity analysis.

Development of Conceptual and Numerical Models

The development of a site-specific conceptual model was used for the development of groundwater predictive simulations. The conceptual and numerical models were developed with the following key aspects:

- The model domain was expanded to include an area of approximately 2.4 square miles;

- The model includes three layers representative of the upper sand/fill, upper clay, and lower sand units cited in the Final RI Report dated March 2002;

- Each of the three layers has a variable-spacing grid that is composed of 102 rows and 123 columns, and the entire model domain has a total of 37,638 discrete grid cells and 51,088 nodes (Figure 1, Finite Difference Grid in 2D, and Figure 2, Finite Difference Grid in 3D);

- Variable elevations are interpolated across the top of the first layer and the bottom of the third layer. All elevation data are based on the survey data of monitoring well and boring log data included in the RI Report. A constant layer thickness of 15 feet (ft) was used for the second layer taken from boring log data (Figure 3, Cross Section of Model Domain);

- Initial hydraulic conductivities of the upper sand/fill and lower sand units (model layers 1 and 3, respectively) were based on pumping test and multiple slug test data found in Appendices O and P of the RI Report

- Layer 1 – A transmissivity of 396 ft^2/d was calculated for layer 1 near the Delaware River (using the late-time drawdown data obtained from the pumping test of MW20S). Assuming an aquifer thickness of 20 ft based on soil boring data the hydraulic conductivity is estimated to be approximately 20 ft/d. The average hydraulic conductivity for the rest of the site is approximately 11 ft/d (multiple slug test data, Appendix O in the RI). The two hydraulic conductivity zones are depicted in plan view in Figure 4.

- Layer 3 - An average hydraulic conductivity of 78 ft/d was used for layer 3 based upon the geometric mean of pumping test data for the lower aquifer.

- The upper clay unit (model layer 2) contains a lower hydraulic conductivity (0.02 ft/d) zone and a high conductivity zone (20 ft/d). Where the layer does not exist the high conductivity zone connects layers 1 and 3 (as shown on Figure 3-11, Areal Extent of Upper Clay Aquitard, in the RI Report).

- Recharge to the model's top layer ranges from approximately 11inches/yr to 22 inches/yr, which is similar to the range in the RI Report. The model area was divided into three different recharge areas as shown in Figure 5. The sloping area of the site near the Delaware River was given a recharge rate of 10.9 inches/yr. The remainder of the site that is flatter and has less runoff was assigned a higher recharge rate of 17.5 inches/yr and the residential area with more open area for recharge was given a recharge rate of 21.9 inches/yr. These recharge rates were developed during the calibrations of the flow model.

Model Boundary Conditions

- Both the Delaware River and Crafts Creek, in layer 1, were simulated through head-dependent boundaries using the river package in MODFLOW. A mean river stage of + 2 ft was calculated from measured river elevations with a head difference of 0.1 ft along the Delaware River (the river gradient). A constant stage of + 5.7 ft was assigned to Crafts Creek (based on a measured water elevation depicted on figures in the RI Report). Tidal fluctuations were not part of the modeling effort. The heads used in the river package were the average head distributions in the Delaware River between low tide and high tide. The pumping wells are within the tidally effected area of the upper and lower sands. However, the average tidal fluctuation of the head in the upper sand is 0.75 feet while the drawdown in the area of the pumping wells is several feet. The average tidal fluctuation of the head in the lower sand is 1.04 feet while the drawdown in the area of the pumping wells is several feet. The drawdown of the pumping wells is much greater than the tidal fluctuation. Therefore, the tidal fluctuations will not have a significant impact on the model predictions. In addition, the modeling takes place over an extended period of time so using the average head in the Delaware River is reasonable.

- Constant head boundaries were used for the southwest portion of the model domain in layer 1 and both the southwest and north portions of the model domain in layer 3. The constant heads range from elevation + 2 to + 28 ft.

- The no flow boundaries in layers 1 and 3 were placed approximately perpendicular to potentiometric surface contours shown in RI Report figures. A short no flow boundary was placed in layer 1 at the location of the dam between the Delaware River and Crafts Creek due to the vertical elevation drop from +5.5 to +2.0 feet for numerical stability reasons; and

- Figures 6 and 7 show the boundary conditions for layers 1 and 3, respectively.

Model Calibration

- Model calibration was completed using steady-state simulations (therefore model output is not affected by aquifer porosity);

- Calibration targets – average groundwater levels measured on May 3, 1990 (see Figures 3-13 and 3-14 in the RI Report);

- Hydraulic conductivities of all three layers and surface infiltration rates were manually adjusted during initial calibration;

- A non-linear parameter estimation program, PEST, was used to future calibrate the model with a total of five parameters, including two hydraulic conductivities and three infiltration rates, and 21 observation data for the upper aquifer only;

- Simulated hydraulic heads matched measured heads for both upper and lower aquifers as presented in Figures 8 and Figure 9;

- The mean error (ME), mean absolute error (MAE), and root mean square error (RMS) were -0.25, +0.62, and +0.98 ft, respectively, for overall aquifer responses (computed versus observed heads, see Figure 10). This error is well below the commonly accepted error with an excellent match between computed and observed heads; and

- Mass balance error, as indicated by the hydrologic (volumetric) budget in the output file, had less than a 0.1 % discrepancy.

Sensitivity Analysis

The purpose of the sensitivity analysis is to quantify the uncertainty in the calibrated model caused by uncertainty in the estimates of aquifer parameters, such as hydraulic conductivity and surface infiltration rates.

The sensitivity analysis was conducted for hydraulic conductivity ranging from one order of magnitude lower to one order of magnitude higher based on the calibrated hydraulic conductivities of 20 ft/d and 10 ft/d for the top layer (Figure 4). The results indicated that:

- The calibrated model is more sensitive to decreasing hydraulic conductivity (Figure 11, Sensitivity Analysis of K);

- The calibrated model is less sensitive to increasing hydraulic conductivity (Figure 11).

The sensitivity analysis was also conducted for the surface recharge rates ranging from 50% lower to 50% higher based on the calibrated recharge rates of 0.0025 ft/d, 0.004 ft/d, and 0.005 ft/d for the zones along the Delaware River, the RSC, and residential area, respectively (Figure 5). The results indicated that:

- The calibrated model is more sensitive to decreasing the infiltration rates (Figure 12, Sensitivity Analysis of Recharge); and

- The calibrated model is less sensitive to increasing infiltration rates (Figure 12).

The calibrated flow model adequately represents site groundwater flow conditions with minimal error and can be used for the basis of the transport model simulations.

CONTAMINANT TRANSPORT MODEL

A contaminant transport model was developed to simulate the current metals contamination in the groundwater at the RSC and predict the metals concentrations in the future under natural attenuation and other various remediation scenarios.

The initial plumes used to calibrate the transport model included three lead and two arsenic plumes in the Upper Sand and one lead, one arsenic and one beryllium plume in the Lower Sand. The concentration utilized for each plume was the highest concentration from data from the RI Report. Table 1 summarizes the well locations, metals concentrations and water quality standards.

Table 1
Historic Metals Concentrations in Groundwater

Plume		Concentration (ug/L)				Water Quality Standard (ug/L)
Well	Metal	1990	1996	1997	1998	
Upper Sand (Layer 1)						
MW-37	Lead	NR	**54.5**	NR	36.1	10
	Arsenic	NR	8.1	NR	**10.6**	8
MW-38	Arsenic	NR	NR	NR	**14.2**	8
MW-42	Lead	NR	**66.8**	NR	1.6	10
MW-31	Lead	NR	NR	NR	**92.4**	10
Lower Sand (Layer 3)						
MW-08d	Lead	**187**	NR	NR	37	10
MW-17D	Arsenic	NR	NR	**95.3**	NR	8
MW-24D	Beryllium	**24.9**	NR	NR	NR	20

NR = Data not reported on RI Report figures or summary tables

Each plume is separate. Plume boundaries were drawn from the impacted monitoring well to the midpoint between the impacted monitoring well and adjacent monitoring wells in which the metal was not detected at a concentration above the water quality standards. The initial concentration within each plume was set at the constant value highlighted in Table 1.

This base case transport model assumes that there is a continuing source of metals contamination and that it has not been removed. Constant mass loading concentrations were varied to determine the mass loading required to produce the concentrations currently observed in the upper and lower aquifers, assuming a 50-year period of loading. Then the simulations were run for an additional 50 years to observe the predicted concentrations and plume geometry. These results were then compared with the current plumes to determine concentration and geometry changes over the 50-year period.

The key aspects of the transport modeling are summarized below:

- The calibrated 3D steady-state flow model was used to represent the hydrogeologic system underneath the RCS.

- Velocity distributions of the 3D flow model were adopted as input to the transport simulation.

- The same spatial discretization of the 3D flow model was adopted for the transport model, with variable grid spacing refined/concentrated in the plume areas.

- Unlike the steady-state 3D flow model, the transport simulation is transient in order to study the change of concentration with time; the total length of time simulated is 100 years which is discretized into only one stress period because of constant external sources used (mean river stage and constant recharge, etc.).

- Initial conditions were set to zero concentration values everywhere in the model domain for arsenic, beryllium, and lead, in order to partially reconstruct the evolution of the existing plumes assumed to originate approximately 50 years ago.

- The mass flux (or Neumann type) boundary conditions were used to represent plume areas with constant mass loading of arsenic, beryllium, and lead either from the vadose zone (for layer 1 due to surface recharge) or from assumed external sources for layer 3.

- The bulk density of the aquifer was set at 157 lb/ft3 (2.52 g/cm3) and the aquifer porosity was assumed to be 0.20.

- Transport simulations included advection, source and sink, and chemical reaction terms. An equilibrium-controlled linear sorption was used for chemical reactions. The distribution coefficients (Kd) of 29 ml/g, 790 ml/g, and 890 ml/g, for arsenic, beryllium, and lead were adopted from Appendix A, Table 5, of Chapter 250 of Title 5, Environmental Protection, of the Pennsylvania Code. This site is in the same physiographic region as Pennsylvania which is just across the river from the site. The transport model is a screening model to determine approximate cleanup times for arsenic, beryllium and lead. There is no specific site data for soil pH, clay content, organic carbon content, mineralogy or water chemistry for the site. There are however pH values for the groundwater at the site. The pH in the upper sand aquifer ranges from 5.6 to 7.0; in the lower aquifer from 4.96 to 6.02 and in the slag area from 6.12 to 8.63. The pHs are in the neutral range in the slag area and the upper sand aquifer and slightly acidic in the lower sand aquifer. The limiting metal for cleanup is the lead, which is in the upper aquifer and the slag area in neutral pH zones. According to the EPA document

"Understanding Variations in Partition Coefficient, Kd Values; Volume II, EPA 402-R-99-004B, August 1999", with equilibrium lead concentrations ranging between 37 and 187 ug/l and soil pH values ranging from 6 to 8, the values of Kd for lead range between 900 and 4970 ml/g. The value used in the model for the lead Kd was 890 ml/g which is the most conservative value of the range that is appropriate for the site. The lower Kd number will allow the lead to clean up faster than using a higher number.

- Groundwater samples were analyzed for total arsenic which is not speciated into arsenate (AsO^{3-}_4) or arsenite AsO^{3-}_3). The oxidation state is very different for the above two forms of arsenic. However, arsenate species are strongly sorbed a near-neutral pH, but arsenite apparently is not strongly adsorbed at any pH value (James I. Drever, 1982). The presence of sulphates can compete with arsenate for sorption sites at acidic pHs, decreasing the arsenates Kd value. Sulphates were not analyzed at the site; however, most of the site has neutral pH ranges in the area of arsenic contamination so acidic pH is not a factor. The Kd values of arsenate range from 23.6 to 156 ml/g with neutral pH (Bucher et al., 1989). Therefore, use of a single value Kd of 29 ml/g for arsenic is conservative (in the low end of the range) and appropriate in the model.

- Zinc concentrations were detected in the lower sand aquifer above the groundwater quality standards (GWQS) in the wells. However, the concentrations were only slightly above the GWQS. In addition, the Kd for zinc is lower than the other metals and would remediate faster. Therefore, zinc was not evaluated in the modeling.

- The lead plumes were reconstructed with calibrated constant mass loading rates of 60,000 ppb, 40,000 ppb, and 50,000 ppb for lead plumes centered in monitoring wells MW31, MW37, and MW42, in layer 1. Figure 13 illustrates lead concentrations with constant mass loading for 50 years in layer 1. Figure 14 depicts lead concentrations with constant mass loading for 100 years in layer 1. A calibrated constant mass-loading rate of 80,000 mg/d was used for the lead plume centered around MW8D in layer 3. Figure 15 illustrates lead concentrations with constant mass loading for 50 years in layer 3. Figure 16 depicts lead concentrations with constant mass loading for 100 years in layer 3. Figures 17 and 18 present lead concentration hydrographs for MW31, MW37, and MW42 in layer 1 and MW8D in layer 3 for both calibrated (50 years) and predicted (100 years) concentrations with assumed constant mass loading from on-site sources.

- The arsenic plumes were reconstructed with calibrated constant mass loading rates of 250 ppb and 320 ppb for arsenic plumes centered around monitoring wells MW37 and MW38, in layer 1. Figure 19 illustrates arsenic concentrations with constant mass loading for 50 years in layer 1. Figure 20 depicts arsenic concentrations with constant mass loading for 100 years in layer 1. A calibrated constant mass-loading rate of 7,000 mg/d was used for the arsenic plume centered around monitoring well MW17D in layer 3. Figure 21 illustrates arsenic concentrations with constant mass loading for 50 years in layer 3. Figure 22 depicts arsenic concentrations with constant mass loading for 100 years in layer 3. Figure 23 presents arsenic concentration hydrographs for MW17D, MW37, and MW38 for both calibrated (50 years) and predicted (100 years) concentrations with assumed constant mass loading from on-site sources.

- The beryllium plume in layer 3 was reconstructed with a calibrated constant mass loading rate of 32,000 mg/d for the plume centered around monitoring well MW24D. Figure 24 illustrates beryllium concentrations with constant mass loading for 50 years in layer 3. Figure 25 depicts beryllium concentrations with constant mass loading for 100 years in layer 3. Figure 26 presents a beryllium concentration hydrograph of MW24D for both calibrated (50 years) and predicted (100 years) concentrations with assumed constant mass loading from on-site sources.

The modeling results indicate that with constant mass loading of arsenic, beryllium and lead, the concentrations in the plumes increase with time but the plume geometry does not expand.

GROUNDWATER REMEDIATION SCENARIOS

The groundwater flow model and the transport model were used to simulate various remediation scenarios to estimate the time to remediate the metals contamination in the groundwater at the RSC. The following scenarios were modeled as they relate to dissolved phase metals contamination:

1. Source removal and natural attenuation.
2. Source removal and active pumping and treating.
3. No source removal and active pump and treat.
4. Hydraulic containment using a cutoff wall in conjunction with extraction wells.

Each of these scenarios is discussed in greater detail below.

Source Removal and Natural Attenuation

This remediation scenario assumes that the sources of groundwater contamination above and below the water table are removed and the remaining dissolved metals are naturally remediated as a result of the flushing action of the ambient groundwater flow system. This scenario was run for lead only. Lead has the highest partitioning coefficient so the clean up time for lead is greater than arsenic or beryllium producing the most conservative remediation time frame. The key aspects of this remediation scenario are summarized below:

- The locations and concentrations used for the lead plumes are taken from Table 1.

- The plume geometries used are the same as in the base case contaminant transport model. Figure 27 illustrates the initial lead concentrations and plume geometries in layer 1. Figure 28 illustrates the initial lead concentrations and plume geometry in layer 3.

- Figures 29 and 30 depict the lead concentrations in layers 1 and 3 after 100 years of natural groundwater flow. The figures show that there was no noticeable reduction in concentrations and plume geometry.

- Figures 31 and 32 are the concentration hydrographs for the lead plumes in layer 1 and layer 3 (MW37, MW42, MW31 and MW8D). The hydrographs illustrate the minimal change in concentrations of less than 1 ppb over the 100-year period.

- The number of pore volume, N_{pv} required to reduce the initial concentration of lead to the target concentration of 10 ug/L was estimated using a mixed linear reservoir model:

  $N_{pv} = -R \ln(Ct/Ci)$

  where:
  R = 1 + Kd (bulk density)/(porosity)
  Ci = initial concentration
  Ct = target concentration

- An estimated 32,840 pore volumes will be needed to reduce initial lead concentration from 187 ug/L (the highest lead concentration) to 10 ug/L.

- A long term modeling run was performed to determine the time required to reduce the lead concentration from 187 ug/L to 10 ug/L under natural groundwater flow conditions. The modeling results suggest that it will take 90,000 years to reduce the concentrations to 10 ug/L. The concentration of 187 ug/l was the highest concentration for lead measured. Recent (1998) low-flow sampling results from the same well was 37 ug/l. At this lower initial concentration, the years to reach 10 ug/l would be less than the 90,000 years. However, it would still take thousands of years to reach the cleanup goal.

The modeling of this remediation scenario indicates that it will take on the order of 90,000 years for the aquifer to reach the cleanup standards for lead using natural remediation.

Source Removal and Pump and Treat

This remediation scenario assumes that the source materials above and below the water table have been removed and that a pump and treat system is installed to capture the lead, arsenic and beryllium contaminant plumes in the Upper and Lower Sands. Based on the calibrated steady-state flow model, the pumping alternative was evaluated through an optimization approach to determine the minimum pumping rate in order to capture the existing dissolved lead, arsenic, and beryllium plumes. The pumping alternative modeling includes the following key aspects:

- A trial-and-error approach was used to evaluate the minimum number of pumping wells and minimum pumping rates required to capture the existing dissolved lead, arsenic and beryllium, plumes in both layers 1 and 3. The calibrated steady-state flow model was used for this effort.

- Extraction wells were assumed fully penetrating either in layer 1 or in layer 3.

- Seven extraction wells were placed in layer 1 with a total pumping rate of 23 gpm (4 wells @ 2 gpm and 3 wells @ 5 gpm), see Figure 33.

- Eight extraction wells were placed in layer 3 with a total pumping rate of 70 gpm (6 wells @ 10 gpm and 2 wells @ 5 gpm), see Figure 33.

- A particle-tracking code, MODPATH 96 3D, was used to delineate capture zones for each extraction well with backward tracking of the particle upgradient.

It appears that these extraction wells will provide adequate capture zones for the existing dissolved lead, arsenic and beryllium plumes, see Figure 33.

Transport simulations were performed for dissolved lead plumes in layers 1 and 3 only using the updated flow field resulting from groundwater extraction. Lead was used for this modeling run because it has the largest partitioning coefficient and would take the longest time to remediate. The following key aspects were used for the modeling of this remedial alternative:

- The existing dissolved lead plumes were used as the initial conditions.

- The flow field resulting from groundwater extraction was used for velocity distribution of the transport run.

- The transport model was run for a 50-year period.

Figures 34 and 35 depict the concentrations of the lead plumes in layers 1 and 3 after 50 years. Figure 36 illustrates the concentration hydrographs for the lead plumes. The figures show that there is minimal change in the lead concentrations after 50 years of pump and treat. Calculations were performed that indicate that it will take 35,000 years for the Lower Sand aquifer to reach groundwater cleanup standards under this pump and treat scenario.

No Source Removal and Pump and Treat

This remediation scenario assumes that the source materials above and below the water table have not been removed and a pump and treat system is installed to capture the lead, arsenic and beryllium contaminant plumes in the Upper and Lower Sand. Transport simulations were performed for dissolved lead plumes using the groundwater extraction flow field in layers 1 and 3. Lead was used for this modeling run because it has the largest partitioning coefficient and will take the longest time to remediate. The following key aspects were used for the modeling of this remedial alternative:

- The existing dissolved lead plumes were used as the initial conditions.

- Based on the re-constructed lead plumes from the base transport cases, the same constant mass loading rates were used for representing the additional source loading.

- The groundwater extraction flow field was used as the basis for velocity distribution of the transport run.

- The transport model was run for 50 years.

Figures 37 and 38 depict the concentrations of the lead plumes in layers 1 and 3 after 50 years. Figure 39 illustrates the concentration hydrographs for the lead plumes. These figures show that, after 50 years of pumping with no source removal, the concentration in the plumes increase in a manner similar to the base case.

Cutoff Wall and Hydraulic Containment

This remediation scenario includes the installation of a linear cutoff wall in conjunction with an extraction well system. For this modeling effort, the cutoff wall was placed along the Delaware River in the area where sediments in the river were impacted by metals contamination. The location of the wall is depicted in Figure 40. An extraction well system was placed inside the wall to capture groundwater that moves downgradient toward the wall. The extraction wells will prevent the groundwater from mounding on the upgradient side of the wall and from moving around the ends of the wall. The following key aspects were used for the modeling of this remedial alternative:

- Based on the calibrated steady-state flow model, a linear cutoff wall was simulated using the horizontal flow barrier package with MODFLOW 96 code.

- The physical properties of the simulated cutoff wall were adopted from the NJ standard for sanitary landfill cutoff walls built with soil-bentonite. These standards include a minimum wall thickness of 3 ft and maximum horizontal hydraulic conductivity of 1 x 10-7 cm/sec.

- The horizontal flow barrier, (i.e., the cutoff wall), was placed across all three layers along the Delaware River. The length of the wall was set at approximately 2,000 feet. The depth of the wall ranged from 63 ft at the western end to 73 ft at the eastern end (Figure 40).

- A trial-and-error approach was used to optimize the number of extraction wells and pumping rate in order to develop dewatering zone(s) that would create a difference in hydraulic head across the cutoff wall.

- Seven extraction wells, screened in both layers 1 and 3, with a total flow rate of 70 gpm were required to lower the head at least 0.5 ft along the southern side of the cutoff wall (Figure 41).

As presented in Figure 41, the hydraulic containment alternative of a cutoff wall in conjunction with seven extraction wells pumping at a total of 70 gpm will provide hydraulic containment in the area of the cutoff wall.

CONCLUSIONS

The following conclusions can be summarized as a result of the groundwater flow and transport modeling effort completed for the RCS:

- Under current conditions, with no source removal, the metals plumes will increase in concentration but will not expand.
- The metals plumes will naturally remediate in approximately 90,000 years if the sources are removed.
- The metals plumes will be remediated in approximately 35,000 years if the sources are removed, a pump and treat system is installed and groundwater is extracted at a rate of approximately 93 gpm.
- If a pump and treat system is installed and the sources are not removed, groundwater will not be remediated.
- Groundwater containment appears to be achievable in the area of impacted river sediments if a cutoff wall, approximately 2000 ft in length and seven extraction wells pumping at a total of 70 gpm are installed.

400408

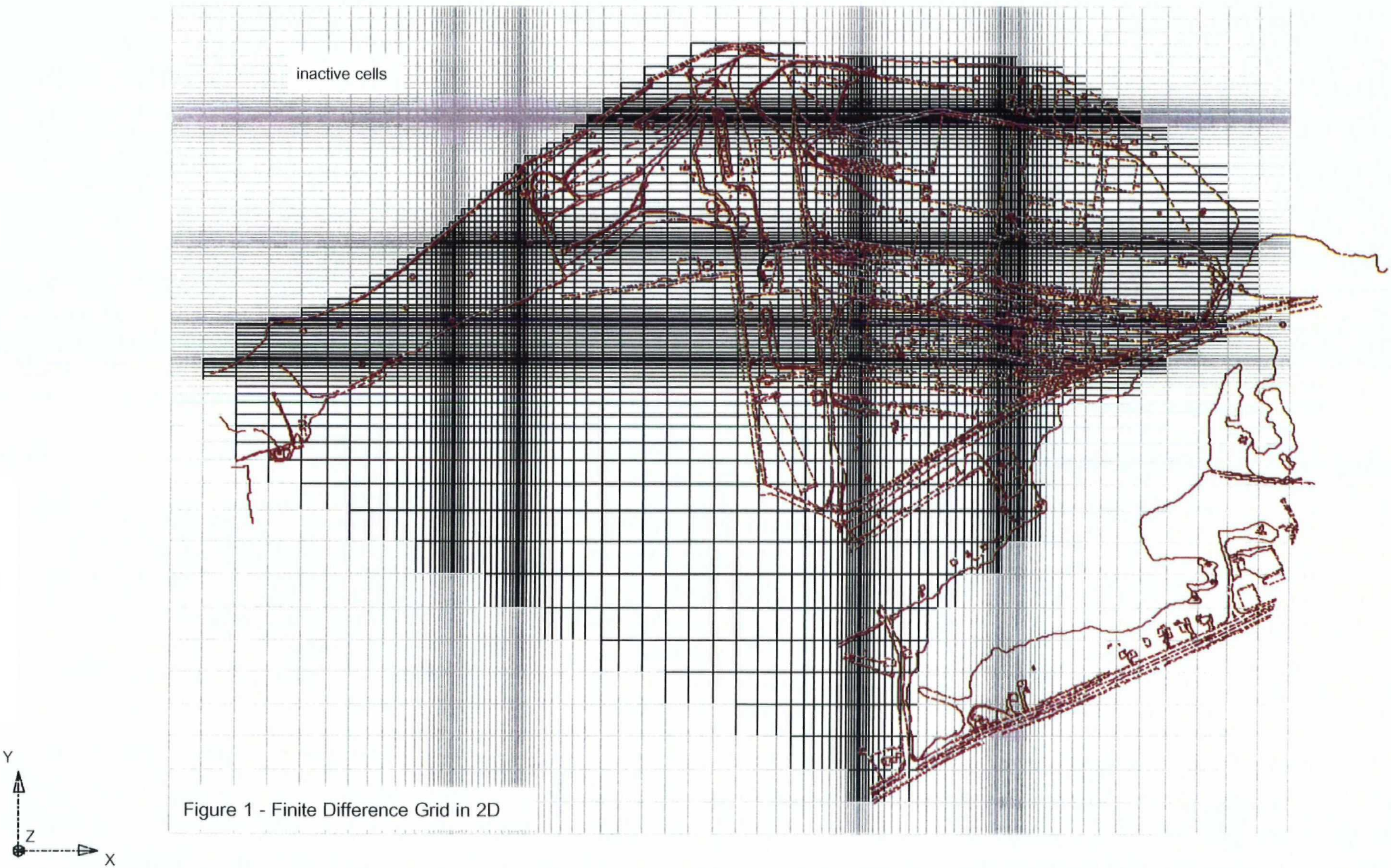
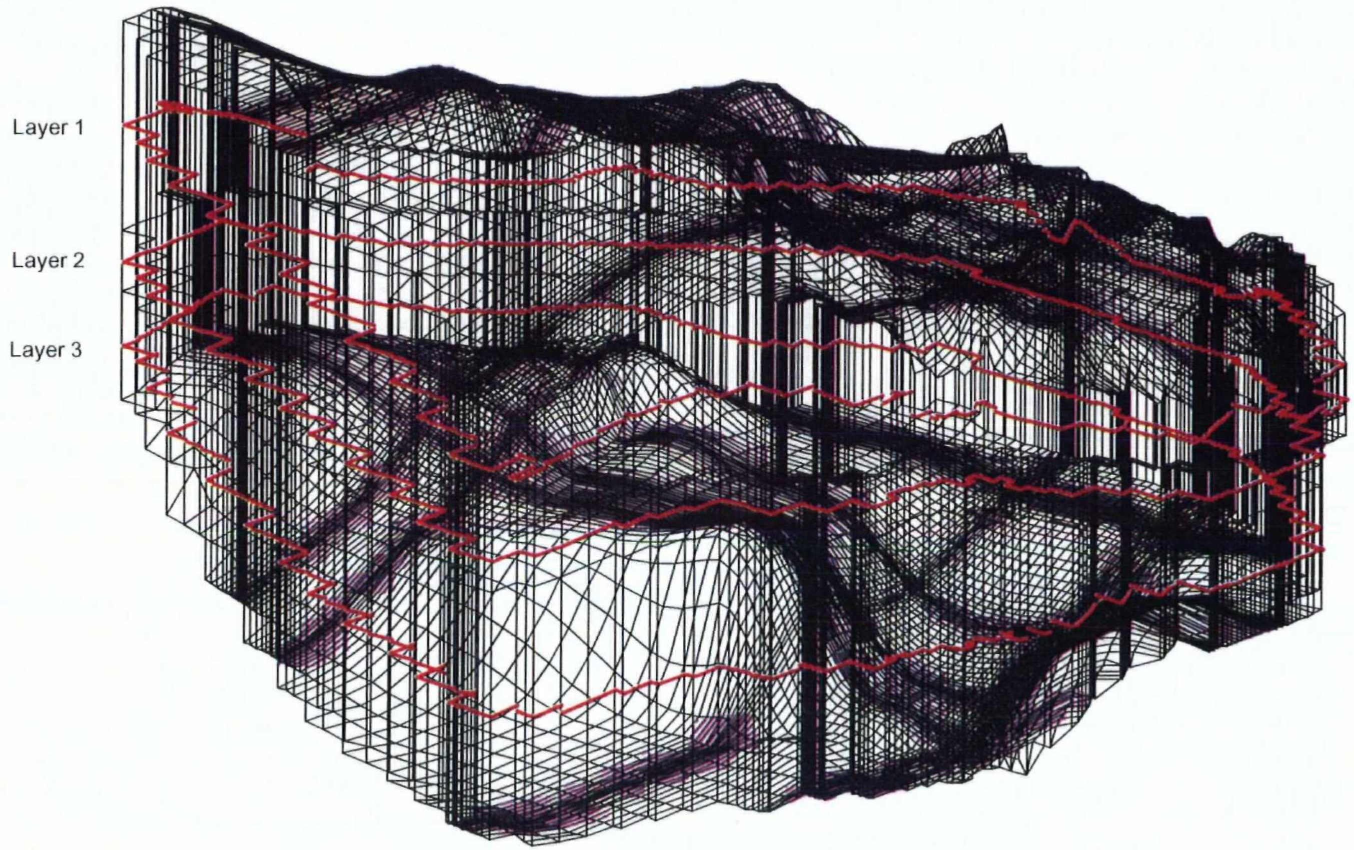


Figure 1 - Finite Difference Grid in 2D



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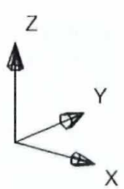


Figure 2 Finite Difference Grid in 3D (not to scale)

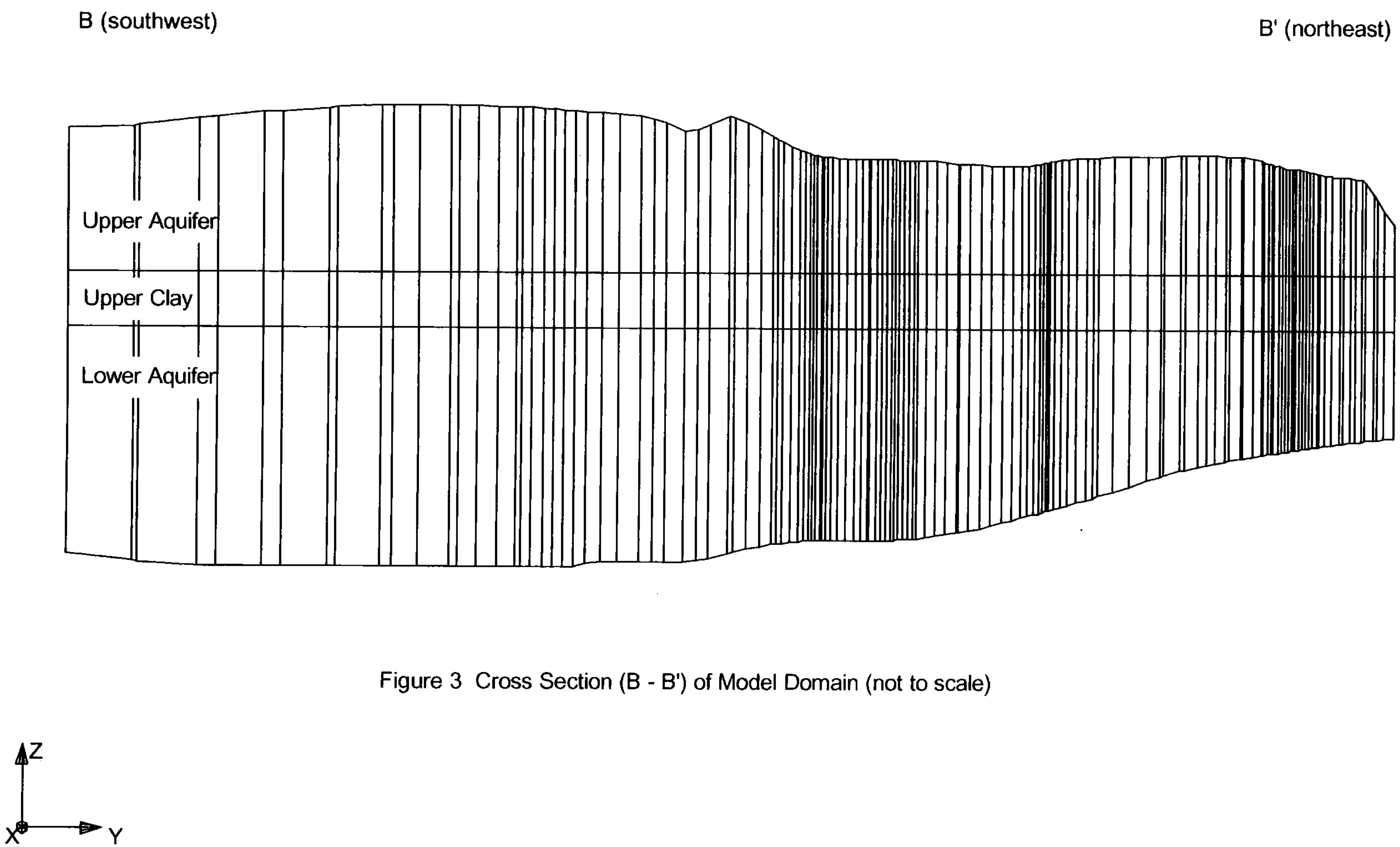


Figure 3 Cross Section (B - B') of Model Domain (not to scale)

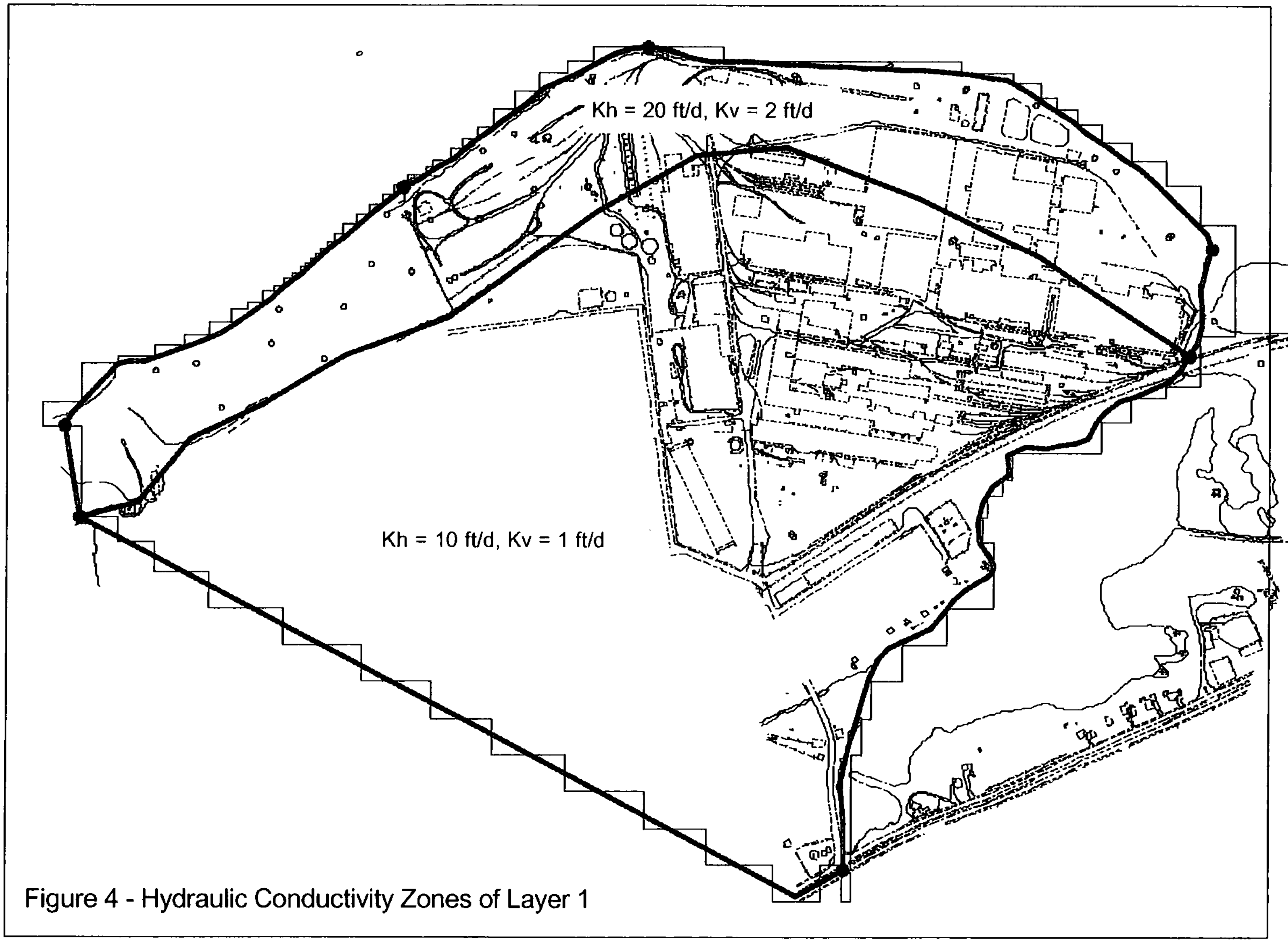
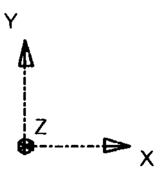


Figure 4 - Hydraulic Conductivity Zones of Layer 1



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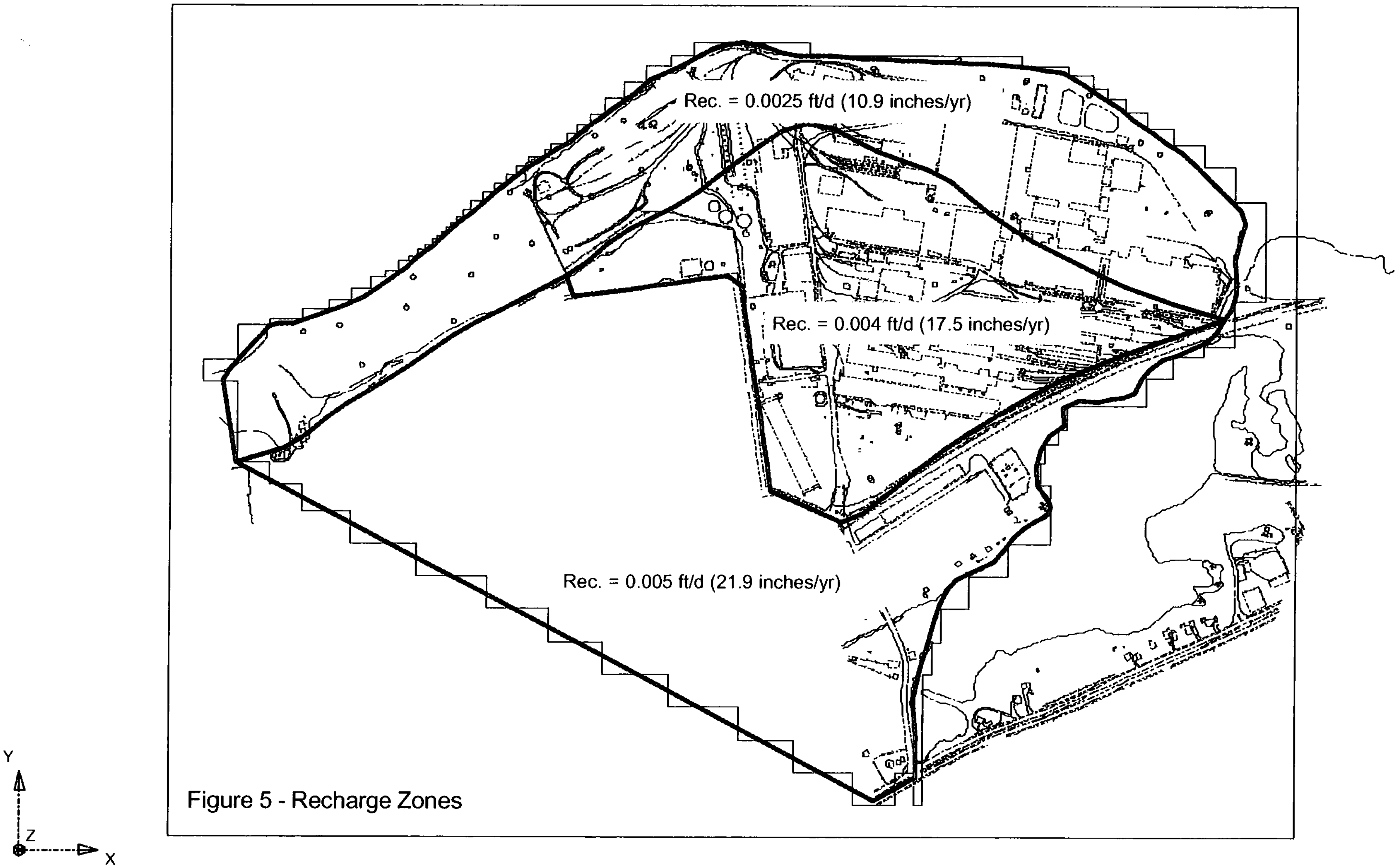

Figure 5 - Recharge Zones

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400413

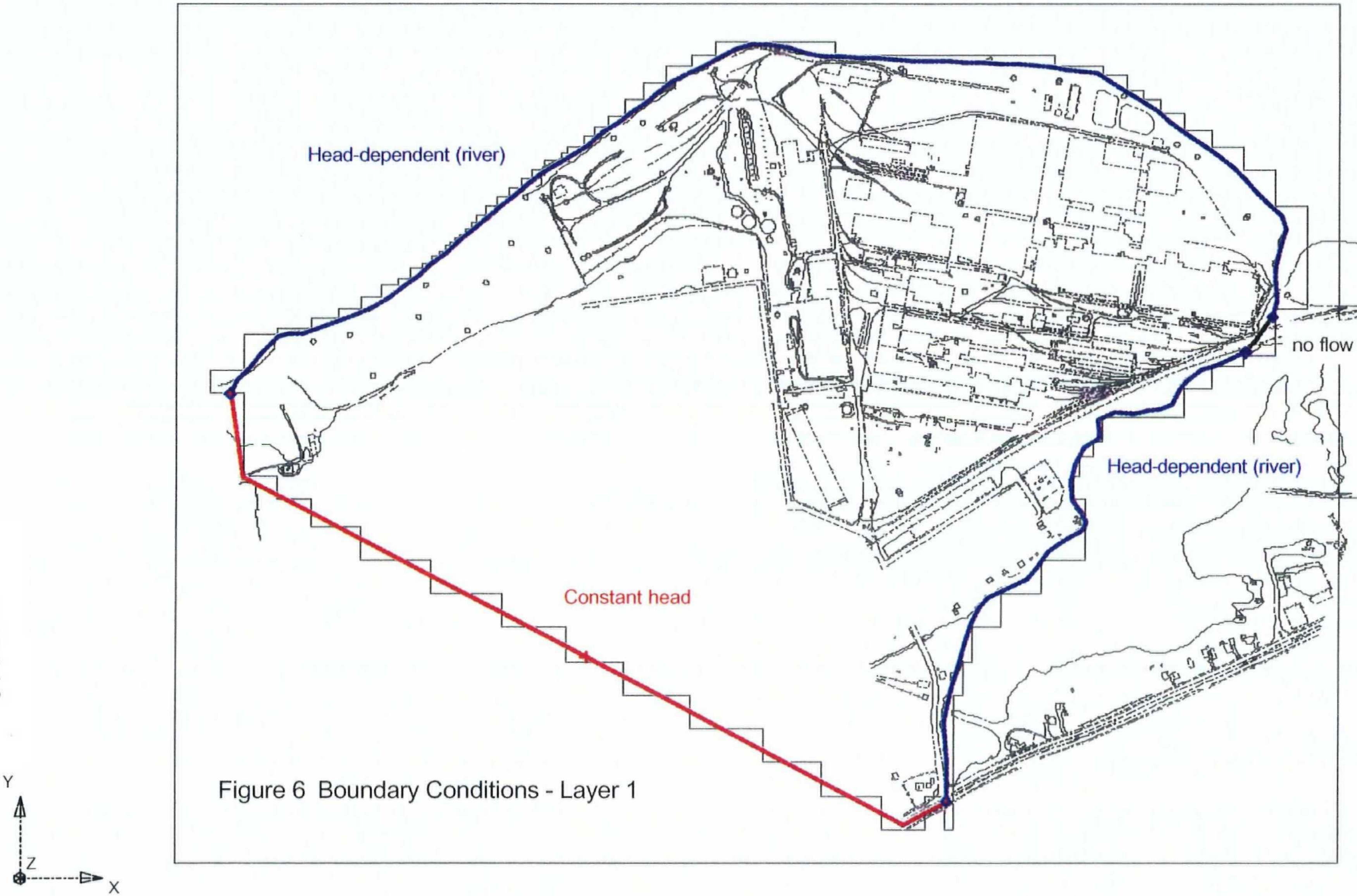


Figure 6 Boundary Conditions - Layer 1

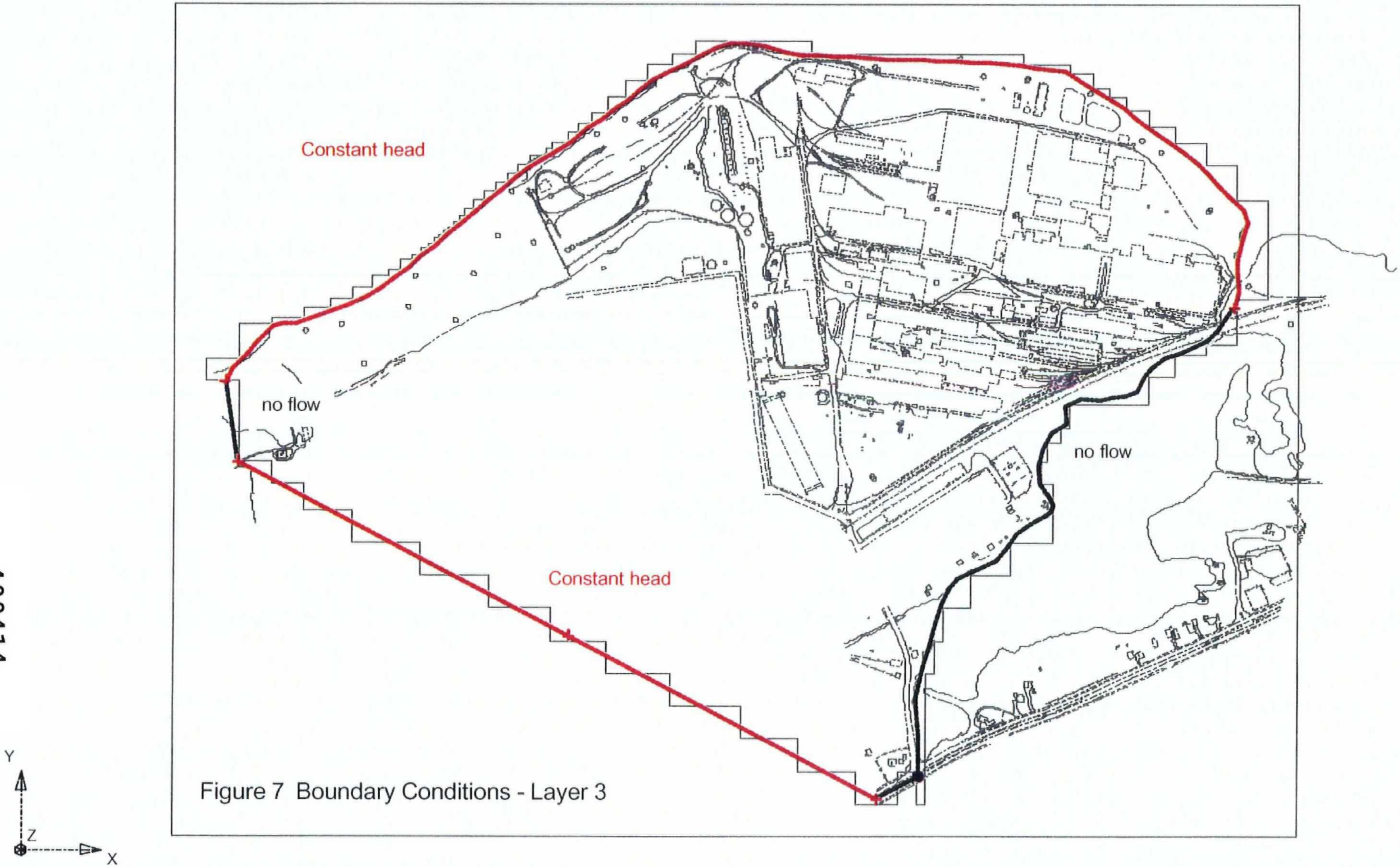


Figure 7 Boundary Conditions - Layer 3

400414

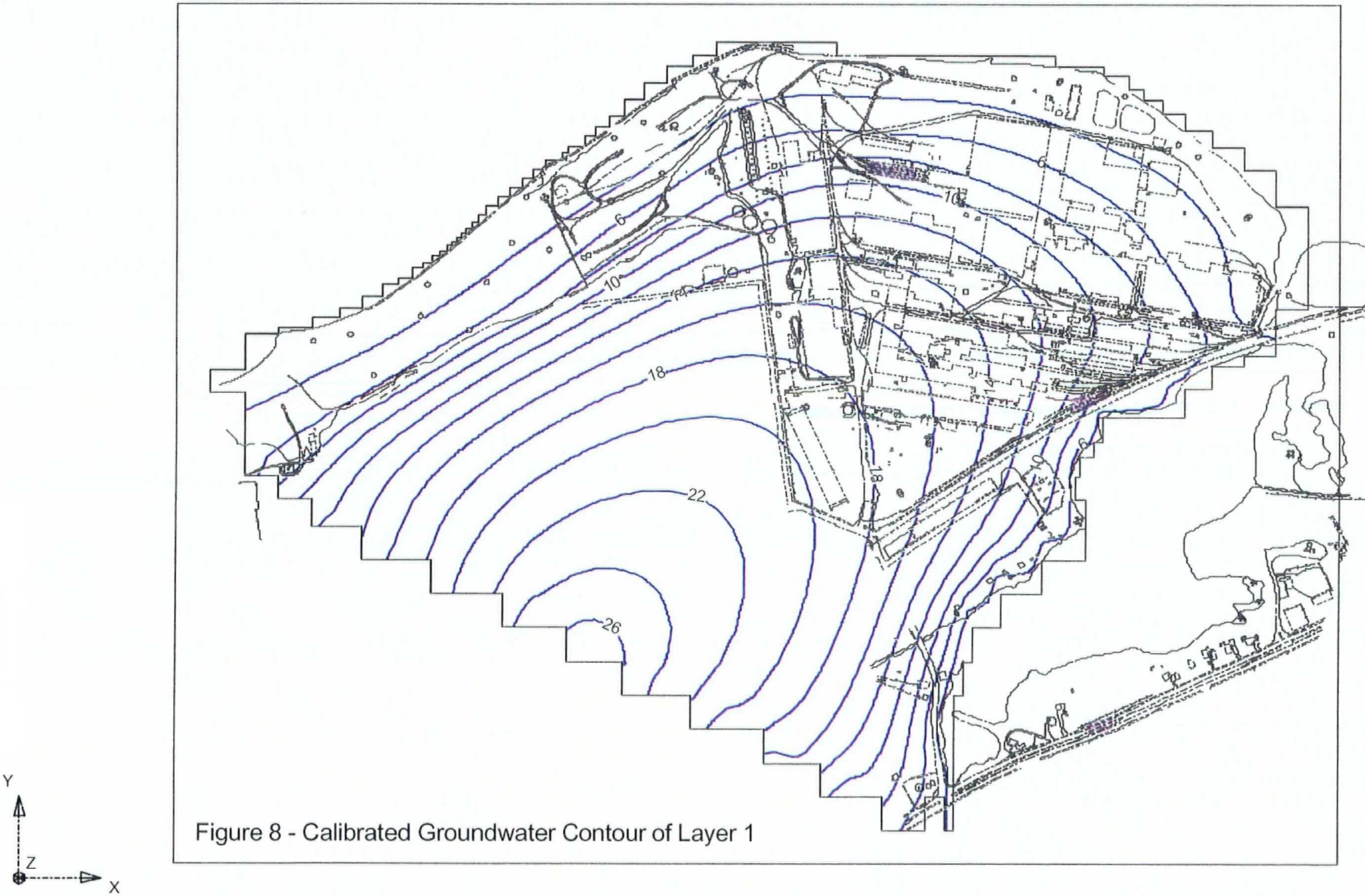


Figure 8 - Calibrated Groundwater Contour of Layer 1

400415

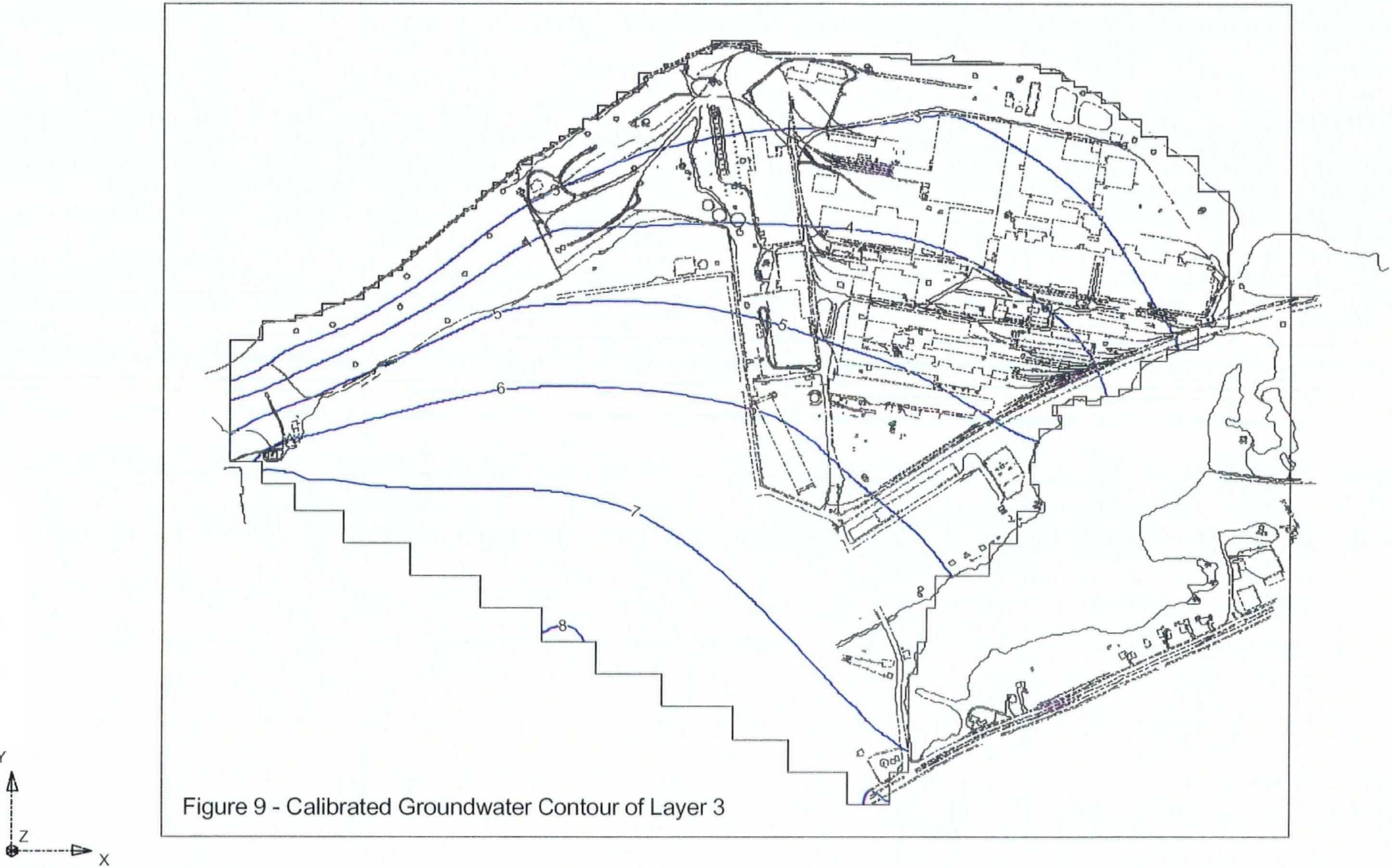
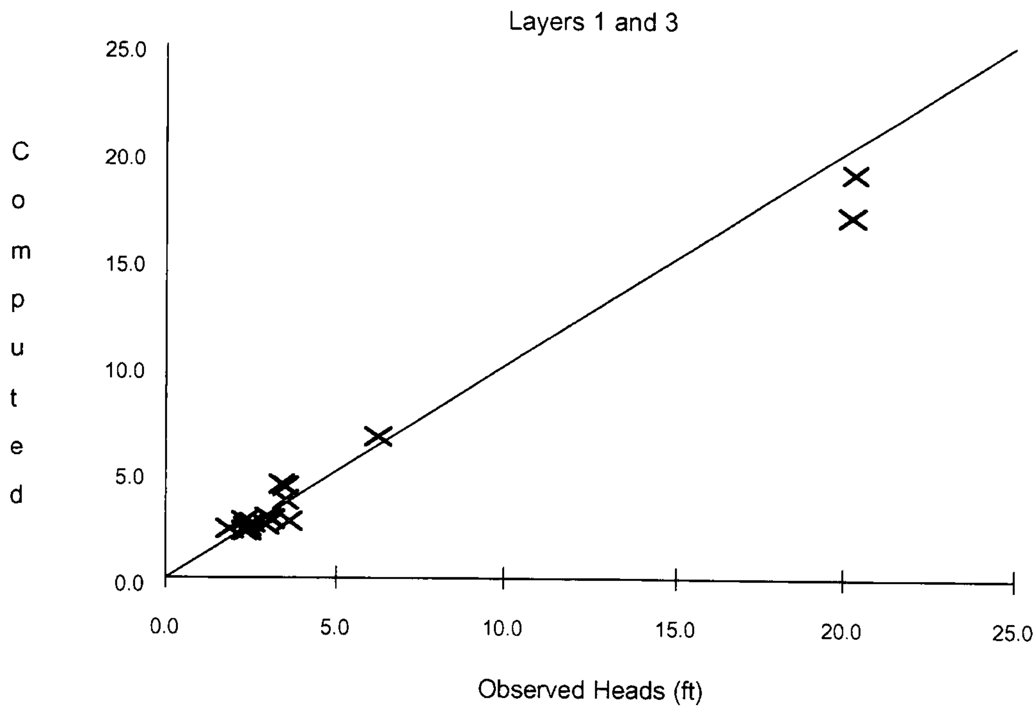


Figure 9 - Calibrated Groundwater Contour of Layer 3

400416

Figure 10 - Computed vs Observed Heads



Error Summary

Layers 1 and 3

Solution / Data set: Flow_C03 / Flow_C03_Heads

Observed measurement: Measurement name

Mean error: -0.25

Mean abs. error: 0.62

Root mean sq. error: 0.98

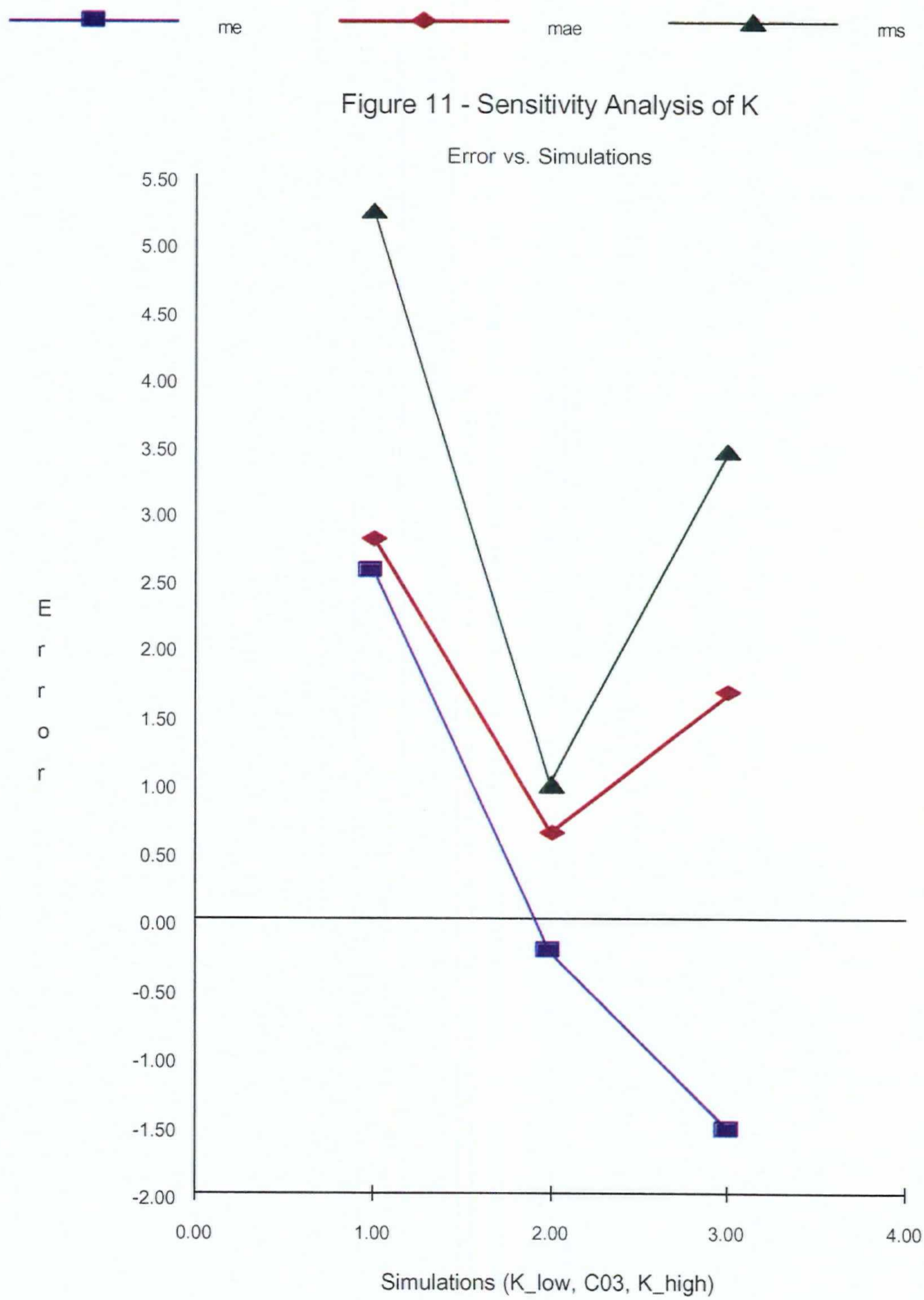
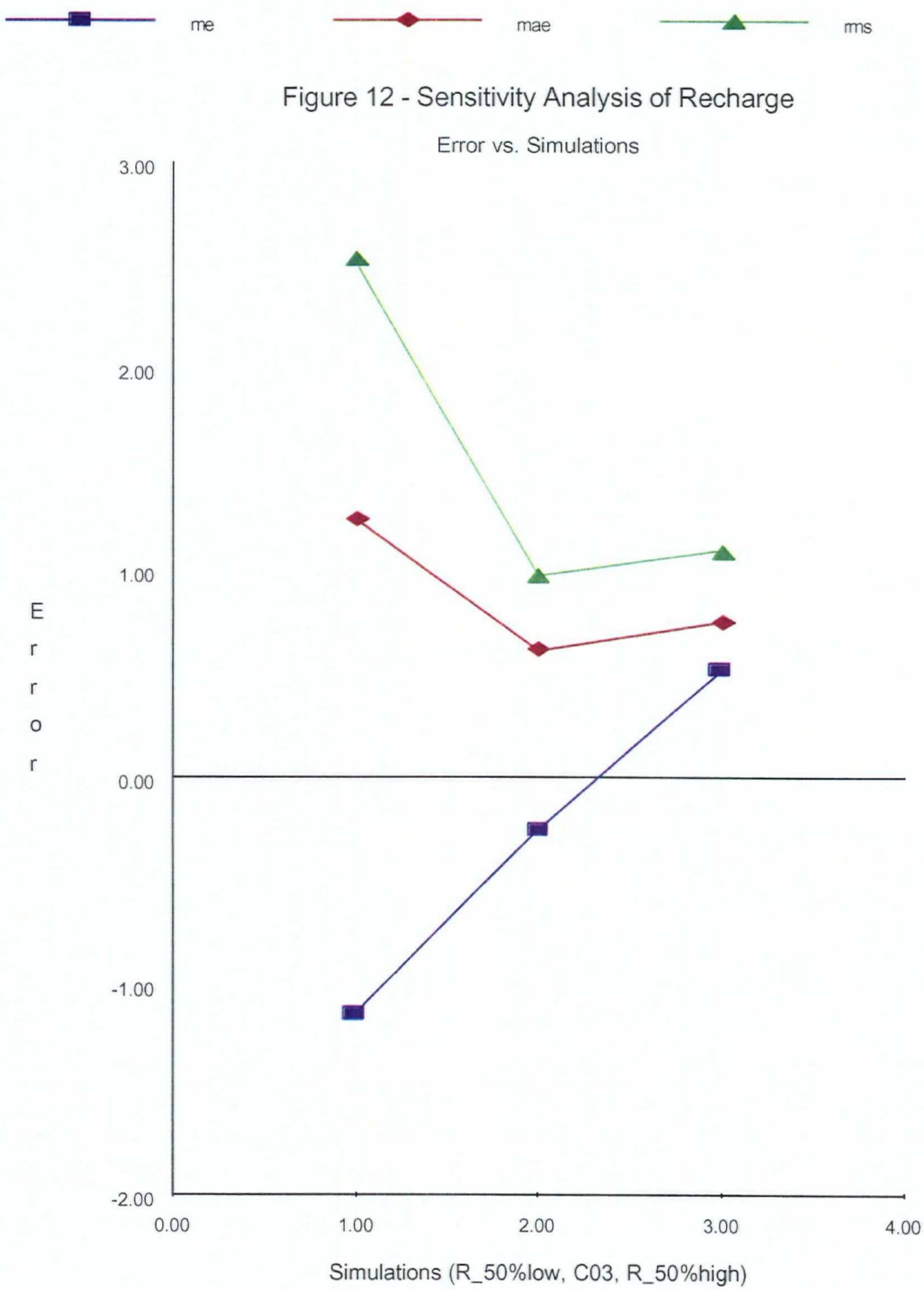


Figure 11 - Sensitivity Analysis of K



me
mae
rms
Figure 12 - Sensitivity Analysis of Recharge
Error vs. Simulations
3.00
2.00
1.00
0.00
-1.00
-2.00
E r r o r
0.00
1.00
2.00
3.00
4.00
Simulations (R_50%low, C03, R_50%high)

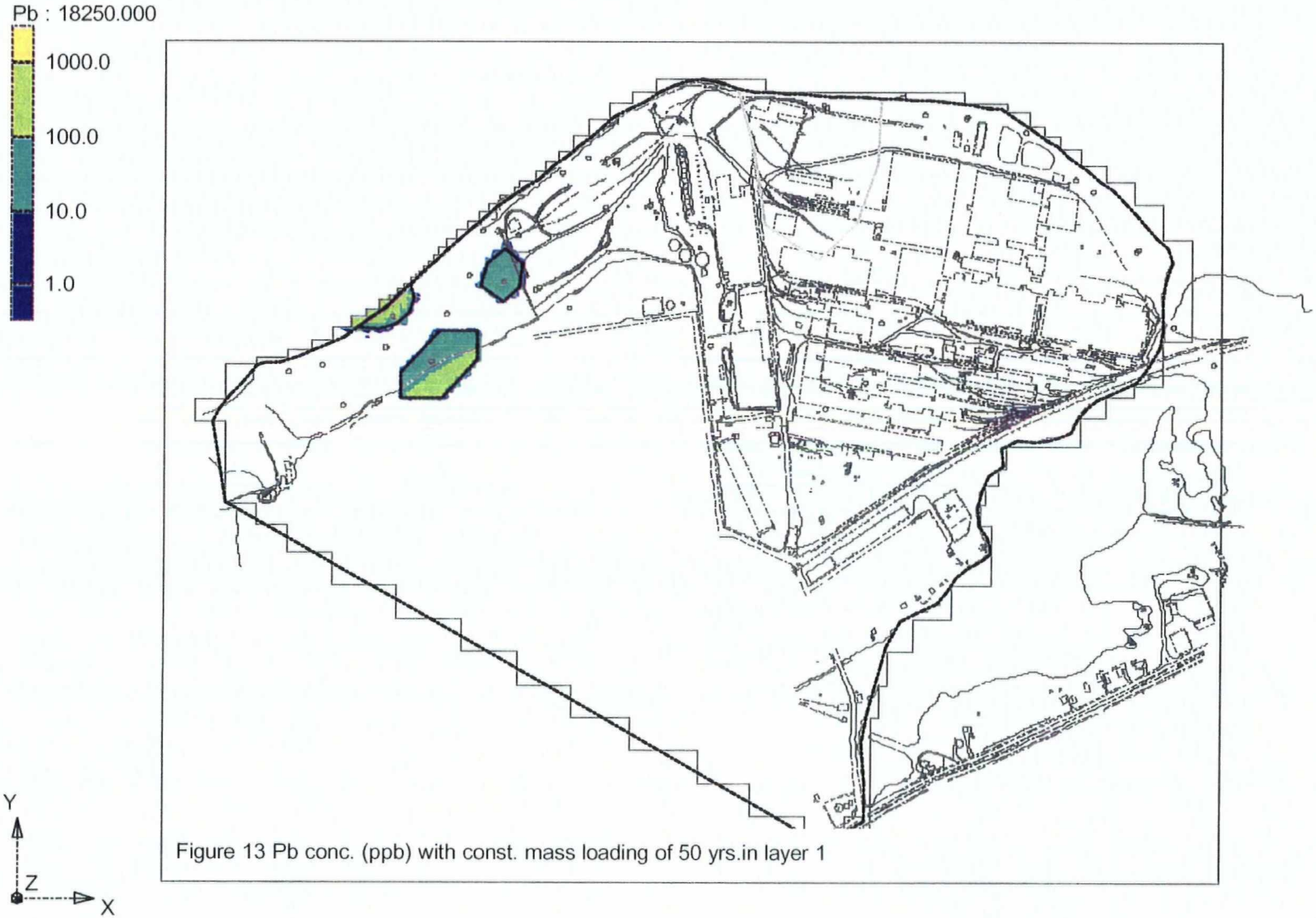


Figure 13 Pb conc. (ppb) with const. mass loading of 50 yrs.in layer 1

400420

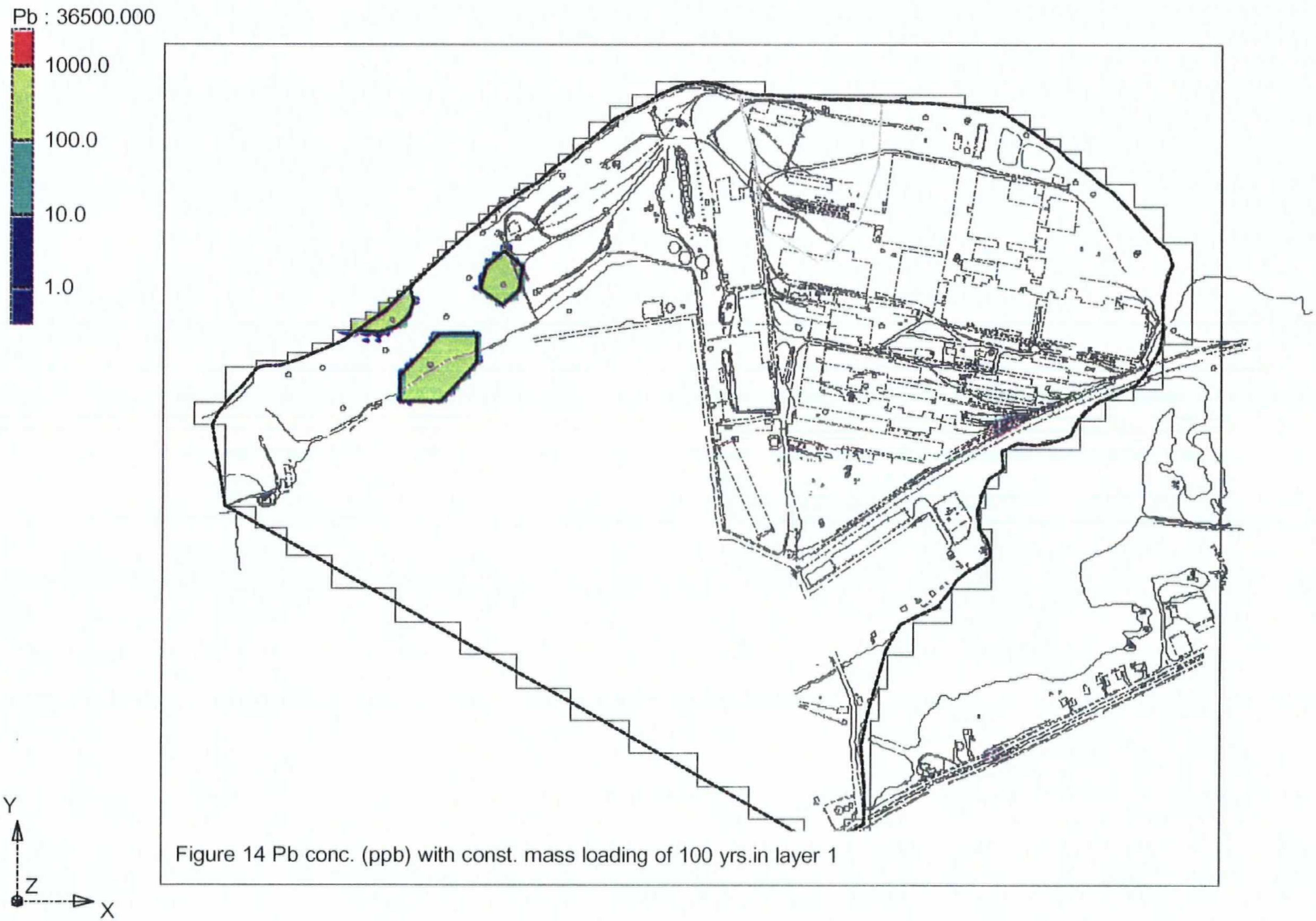


Figure 14 Pb conc. (ppb) with const. mass loading of 100 yrs.in layer 1

400421

Figure 15 Pb conc. (ppb) with const. mass loading of 50 yrs.in layer 3

400422

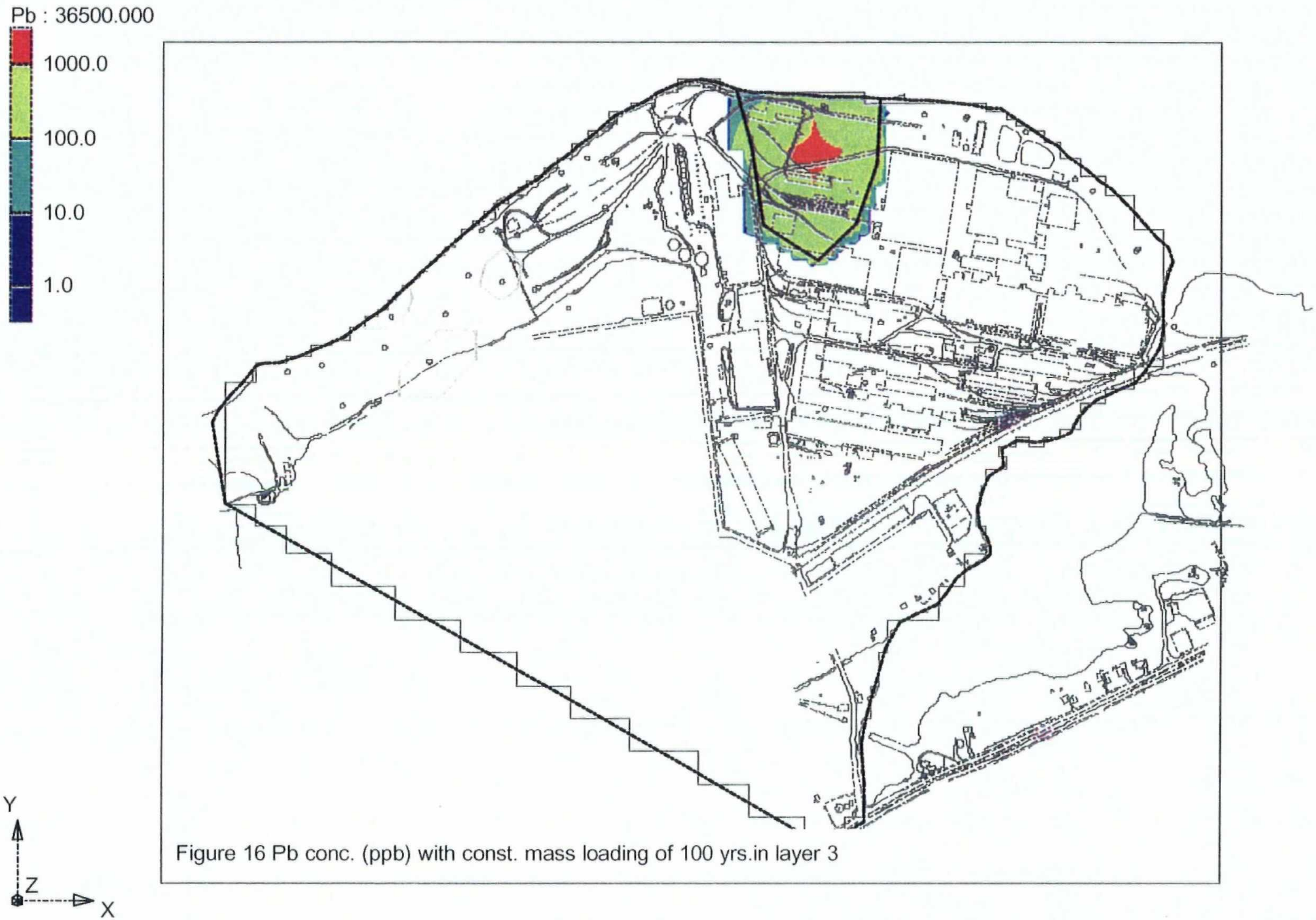
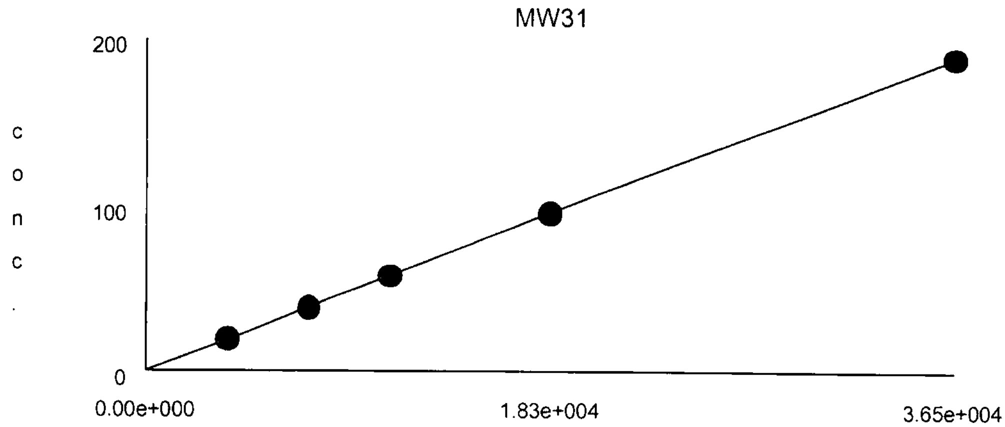
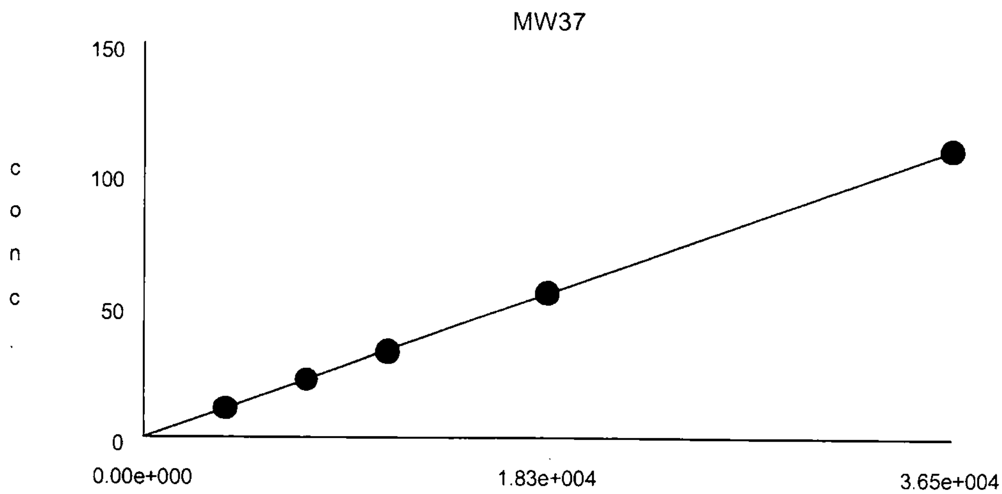


Figure 16 Pb conc. (ppb) with const. mass loading of 100 yrs.in layer 3

400423

Figure 17 Pb conc. (ppb) vs time (layer 1)





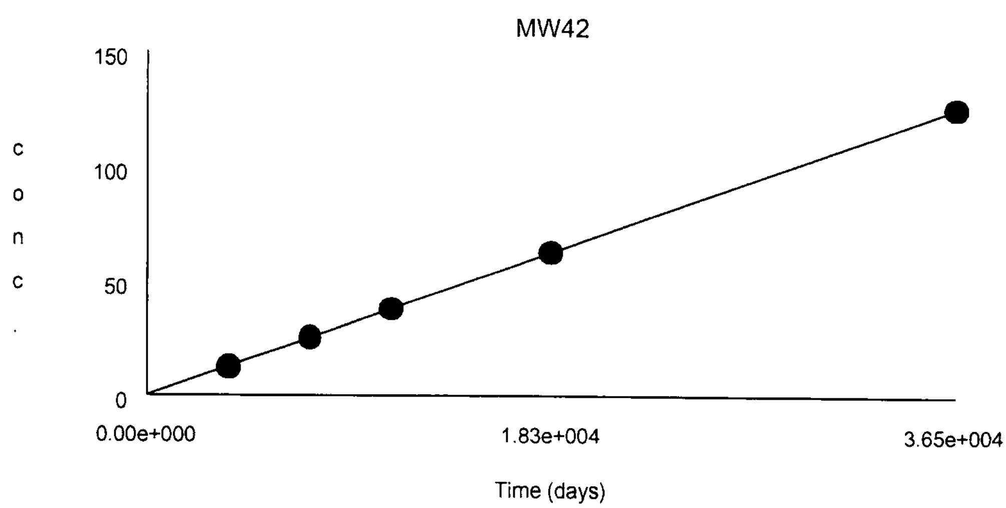
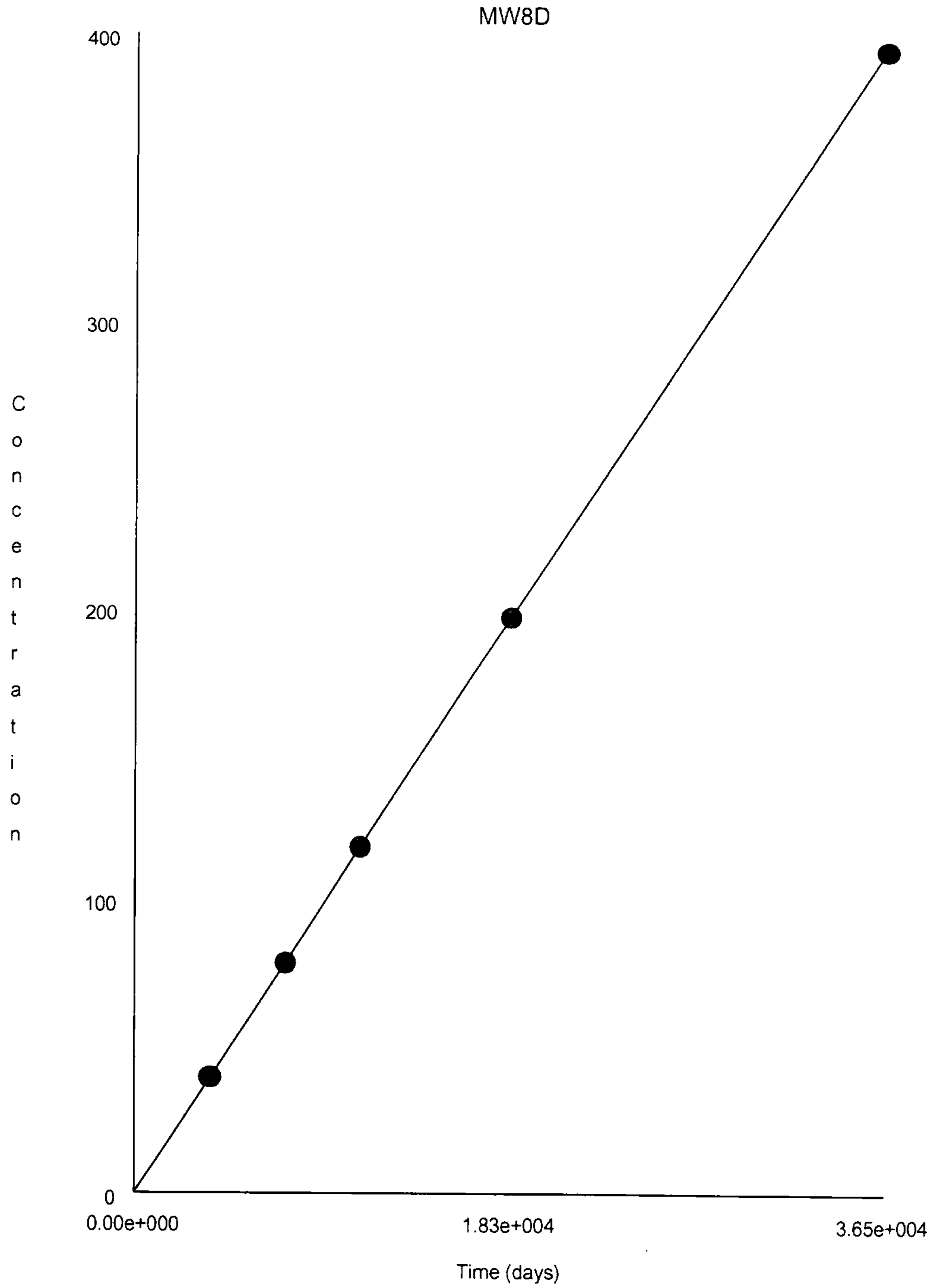


Figure 18 Pb conc. (ppb) vs time (layer 3)



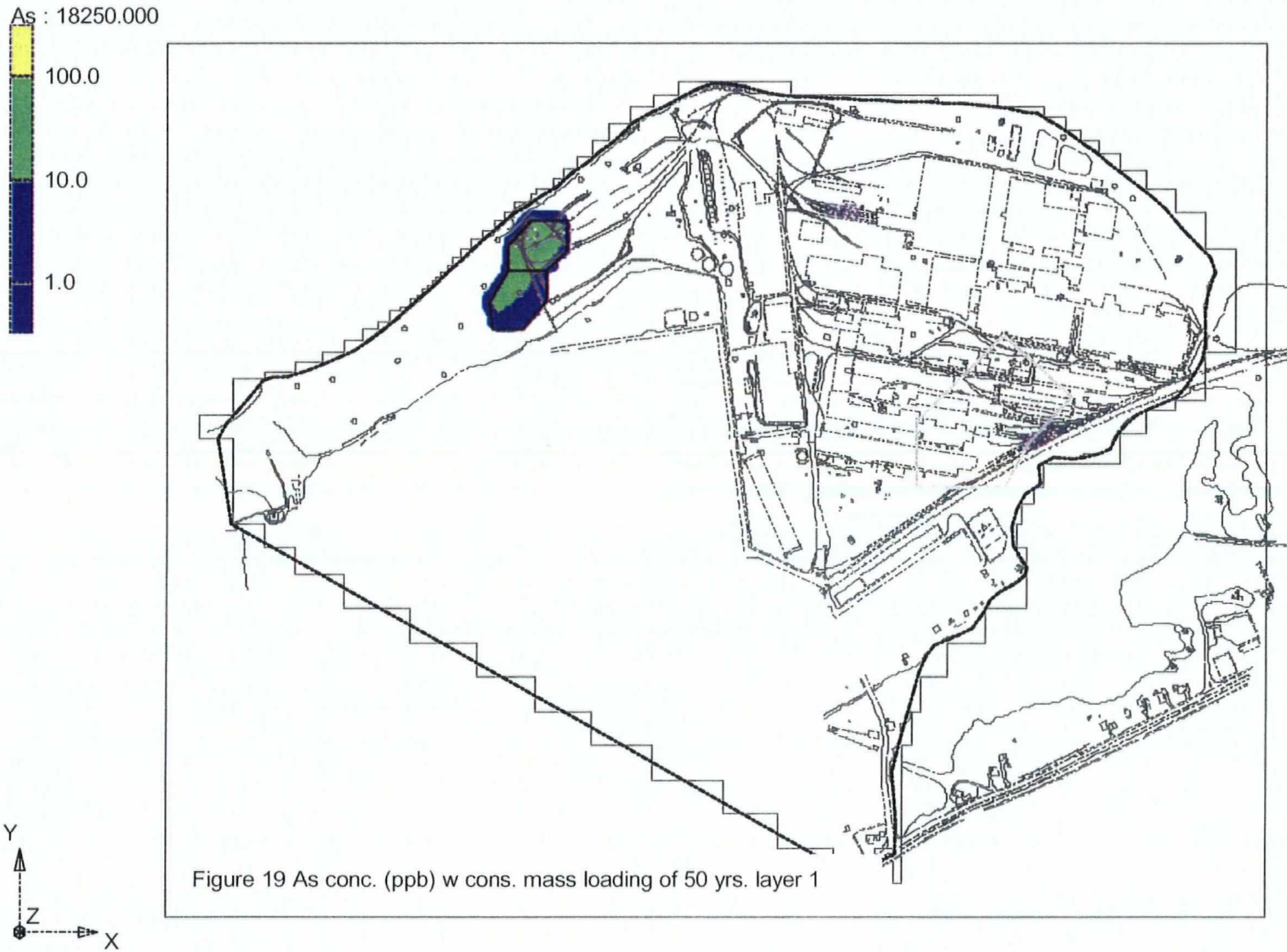


Figure 19 As conc. (ppb) w cons. mass loading of 50 yrs. layer 1

400426

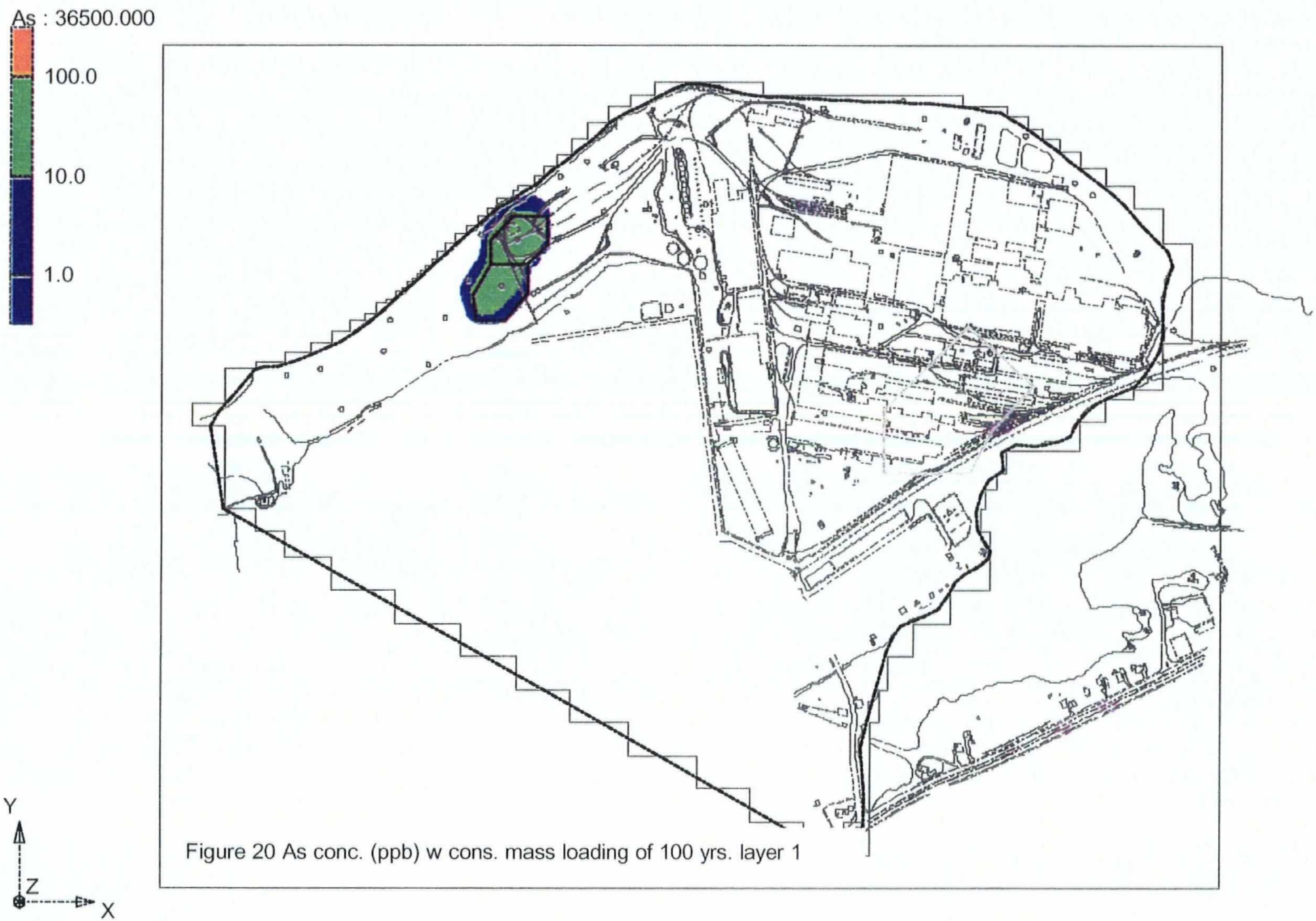


Figure 20 As conc. (ppb) w cons. mass loading of 100 yrs. layer 1

400427

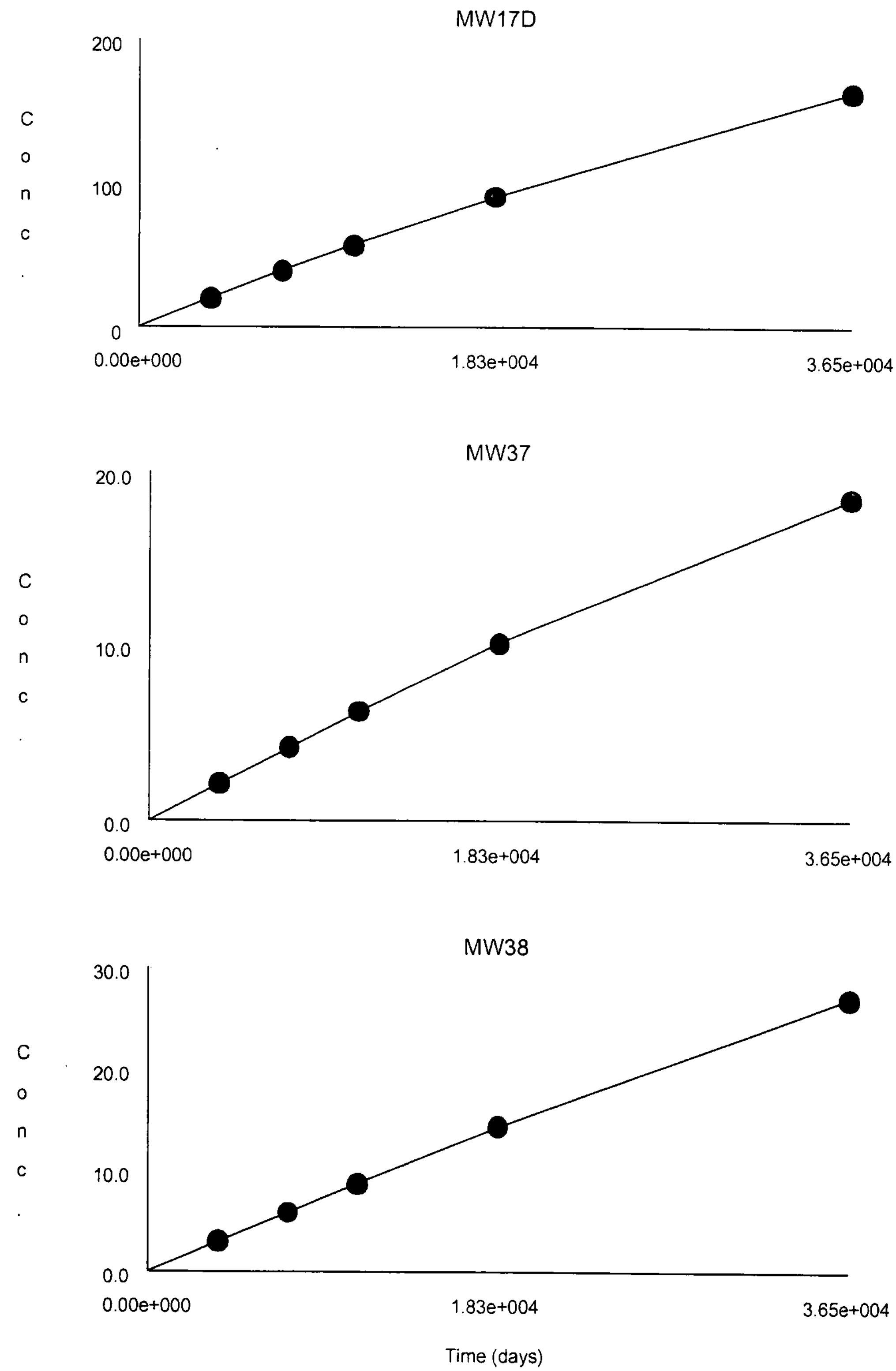
Figure 21 As conc. (ppb) w cons. mass loading of 50 yrs. layer 3

400428

Figure 22 As conc. (ppb) w cons. mass loading of 100 yrs. layer 3

400429

Figure 23 As conc. (ppb) vs time



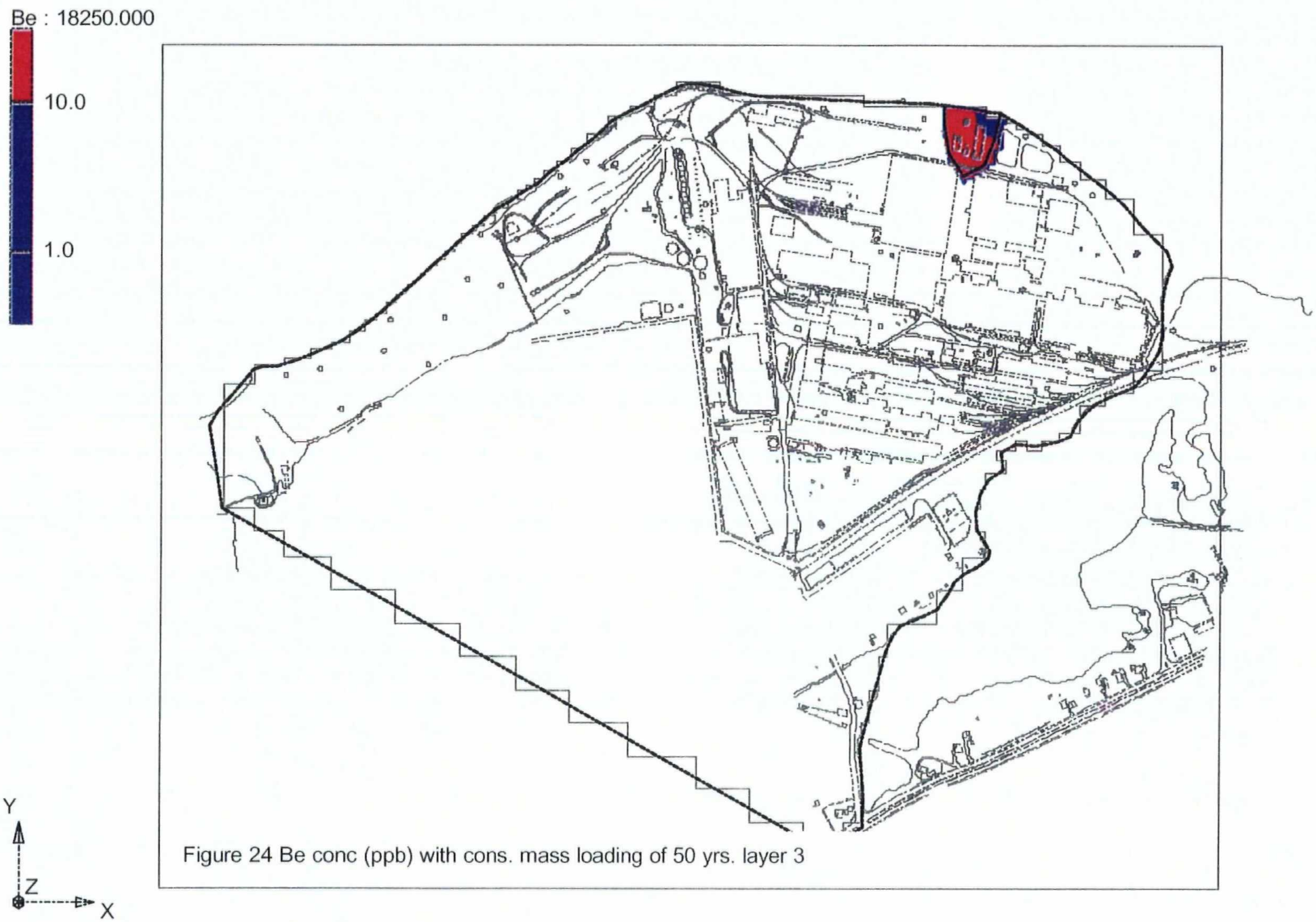


Figure 24 Be conc (ppb) with cons. mass loading of 50 yrs. layer 3

400431

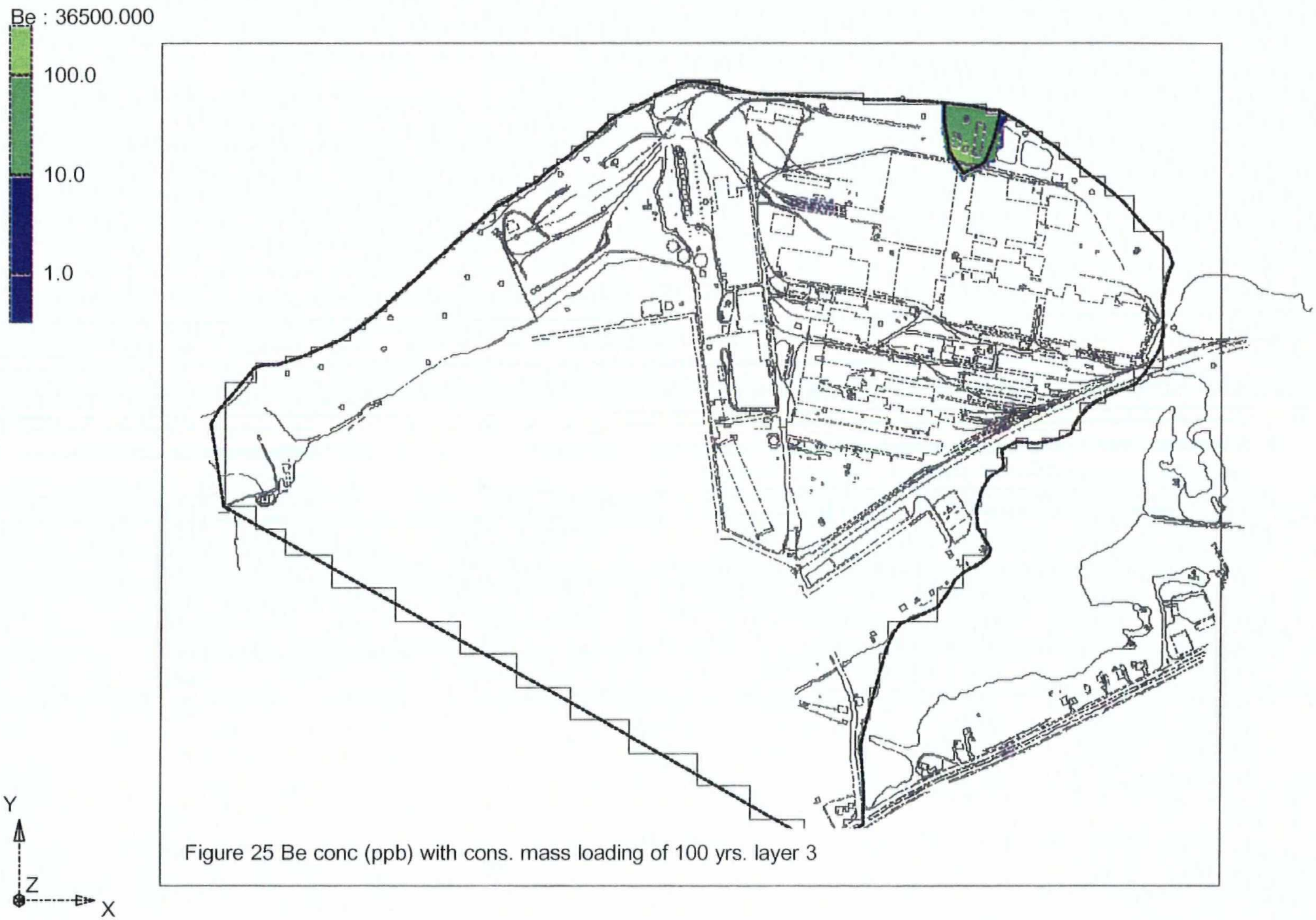
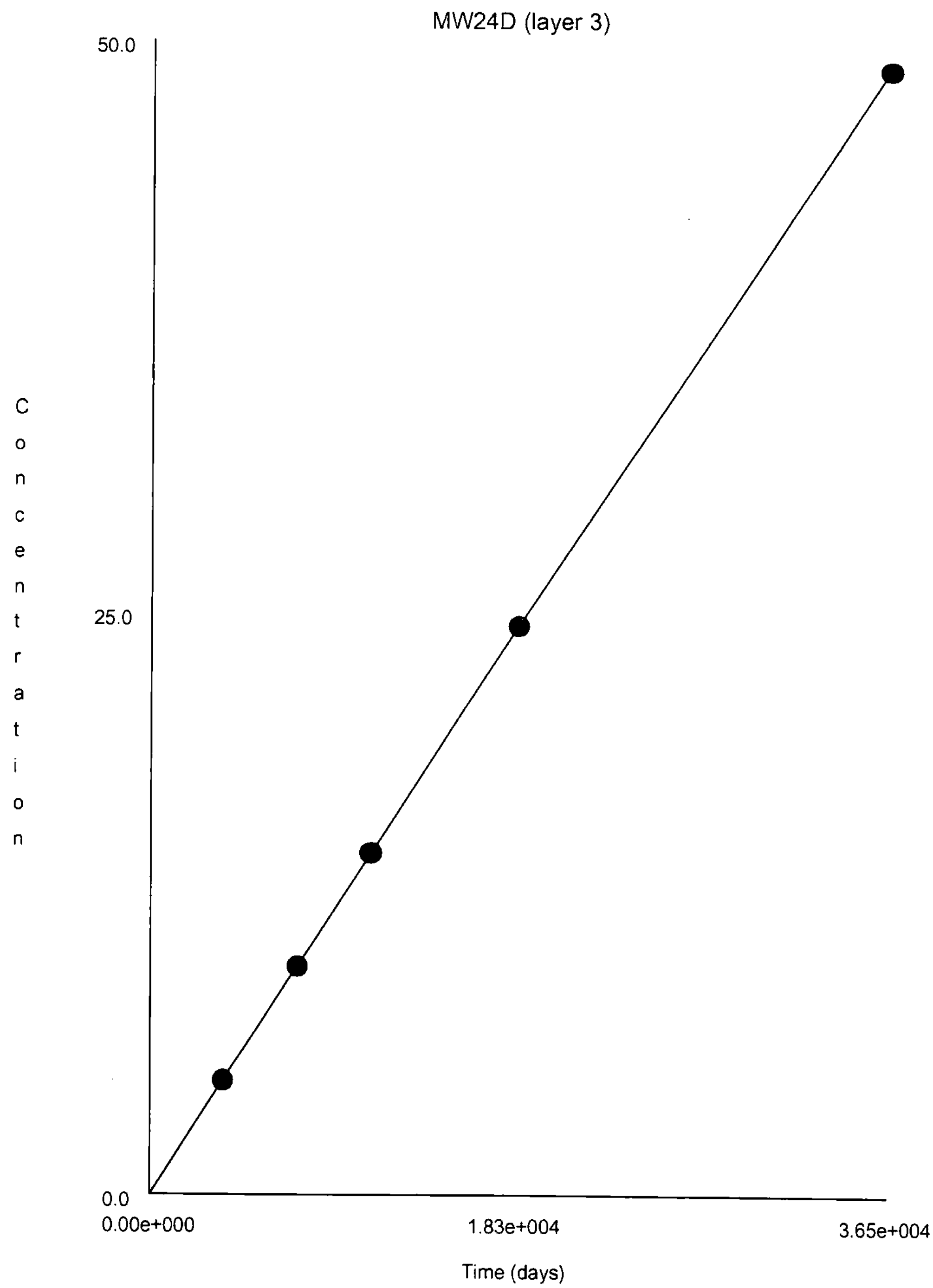


Figure 25 Be conc (ppb) with cons. mass loading of 100 yrs. layer 3

400432

Figure 26 Be conc. (ppb) vs time



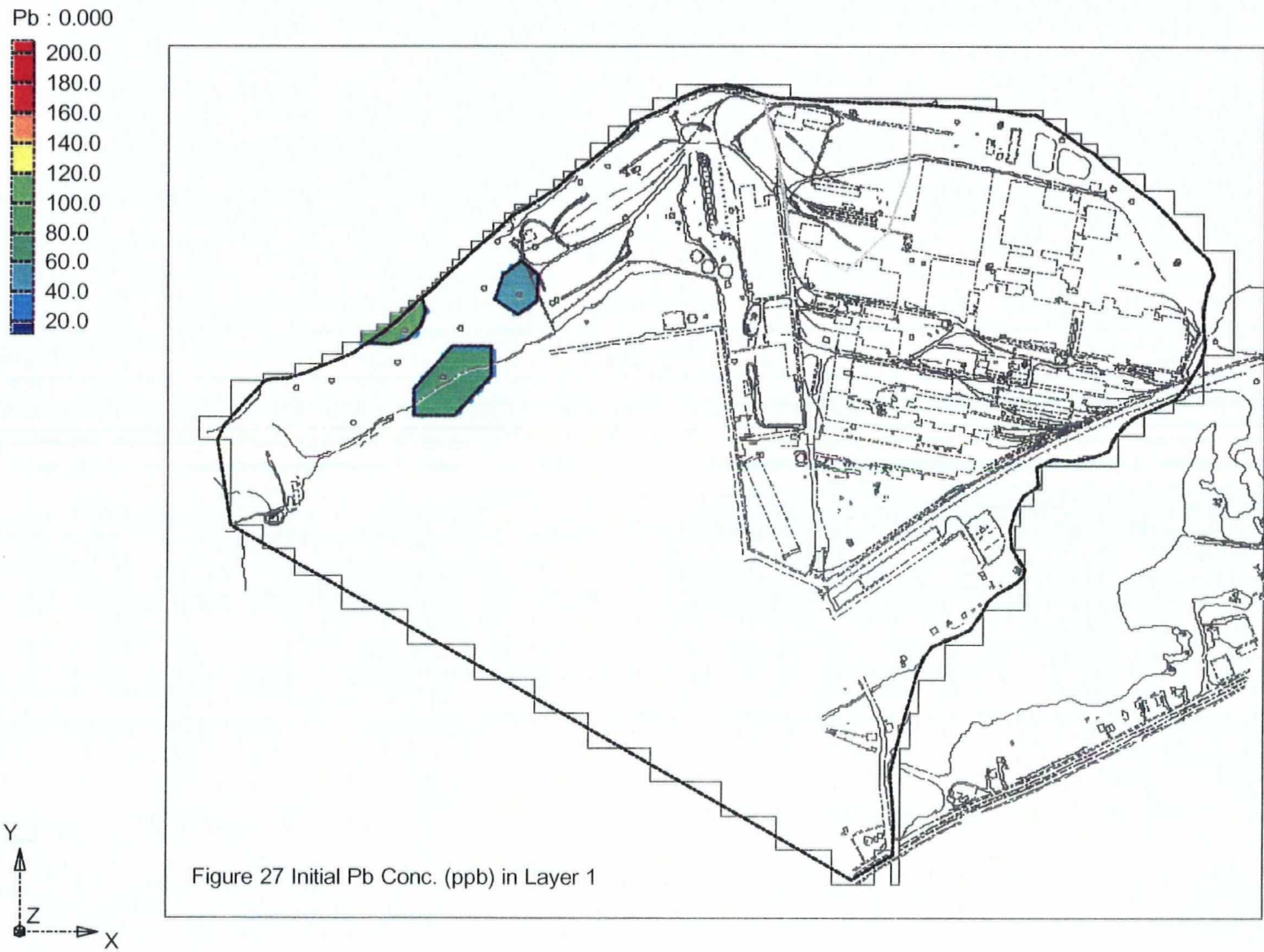


Figure 27 Initial Pb Conc. (ppb) in Layer 1

400434

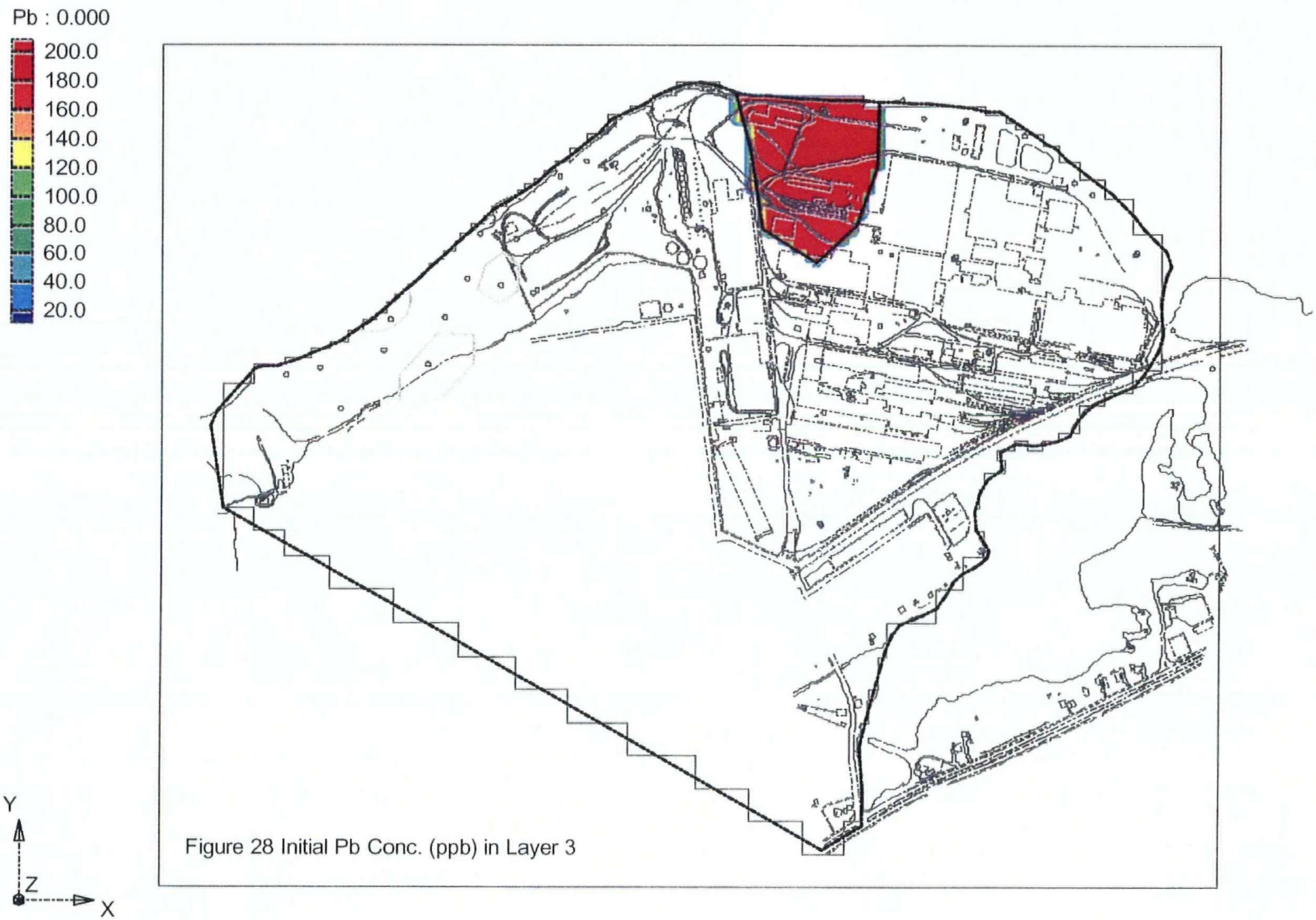


Figure 28 Initial Pb Conc. (ppb) in Layer 3

400435

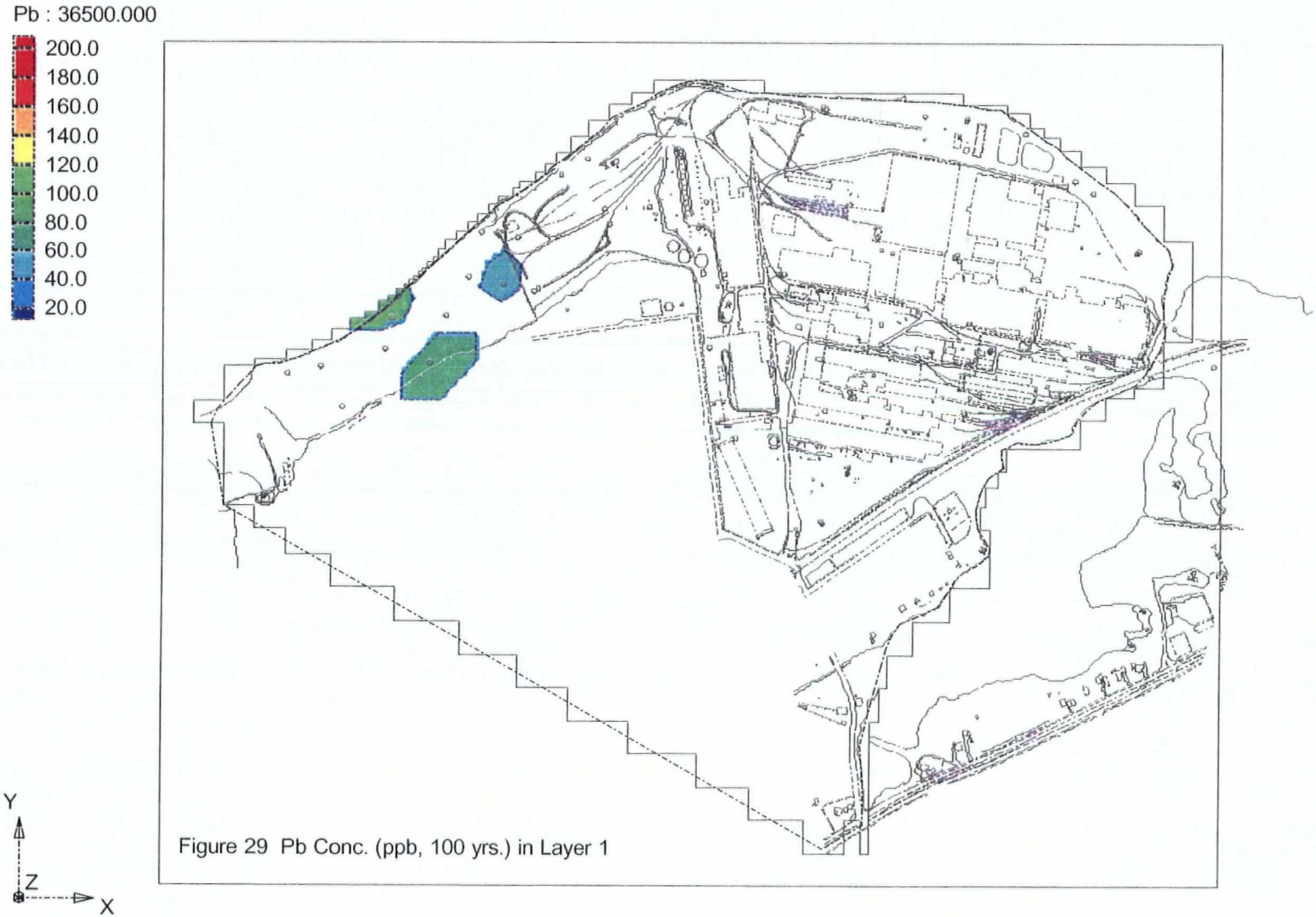


Figure 29 Pb Conc. (ppb, 100 yrs.) in Layer 1

400436

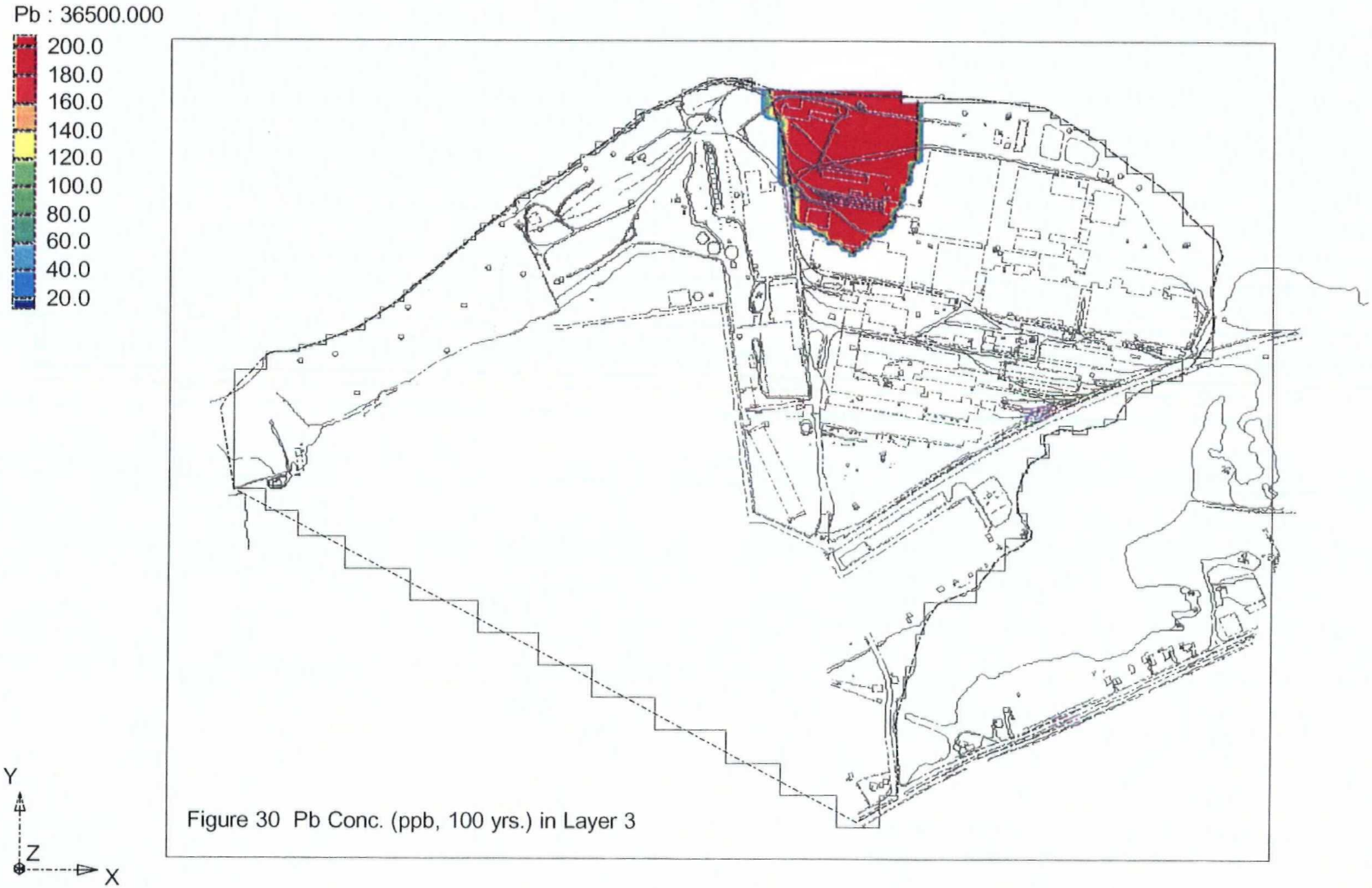
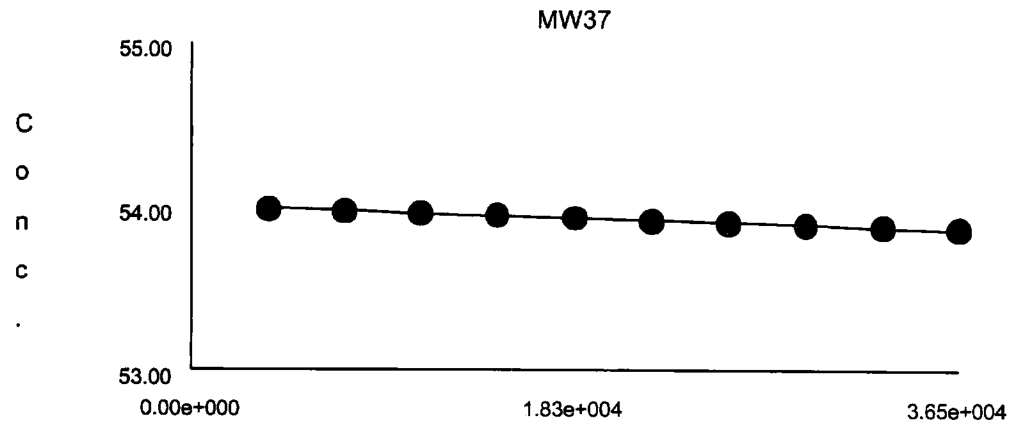
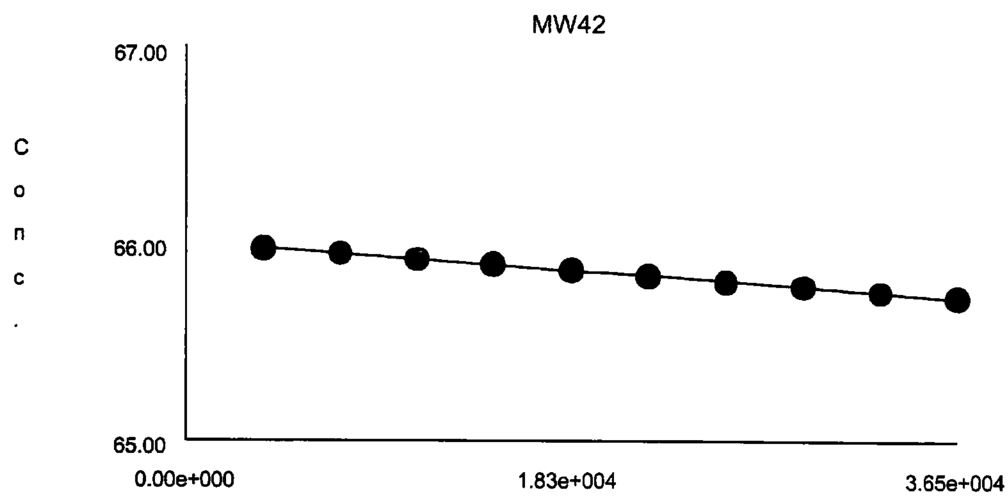


Figure 30 Pb Conc. (ppb, 100 yrs.) in Layer 3

400437

Figure 31 Pb conc. (ppb) vs. time





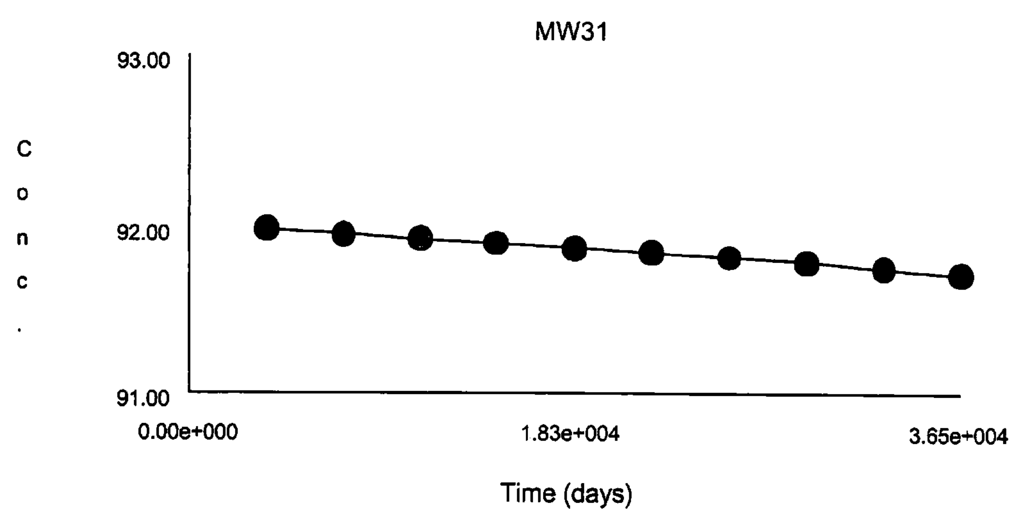
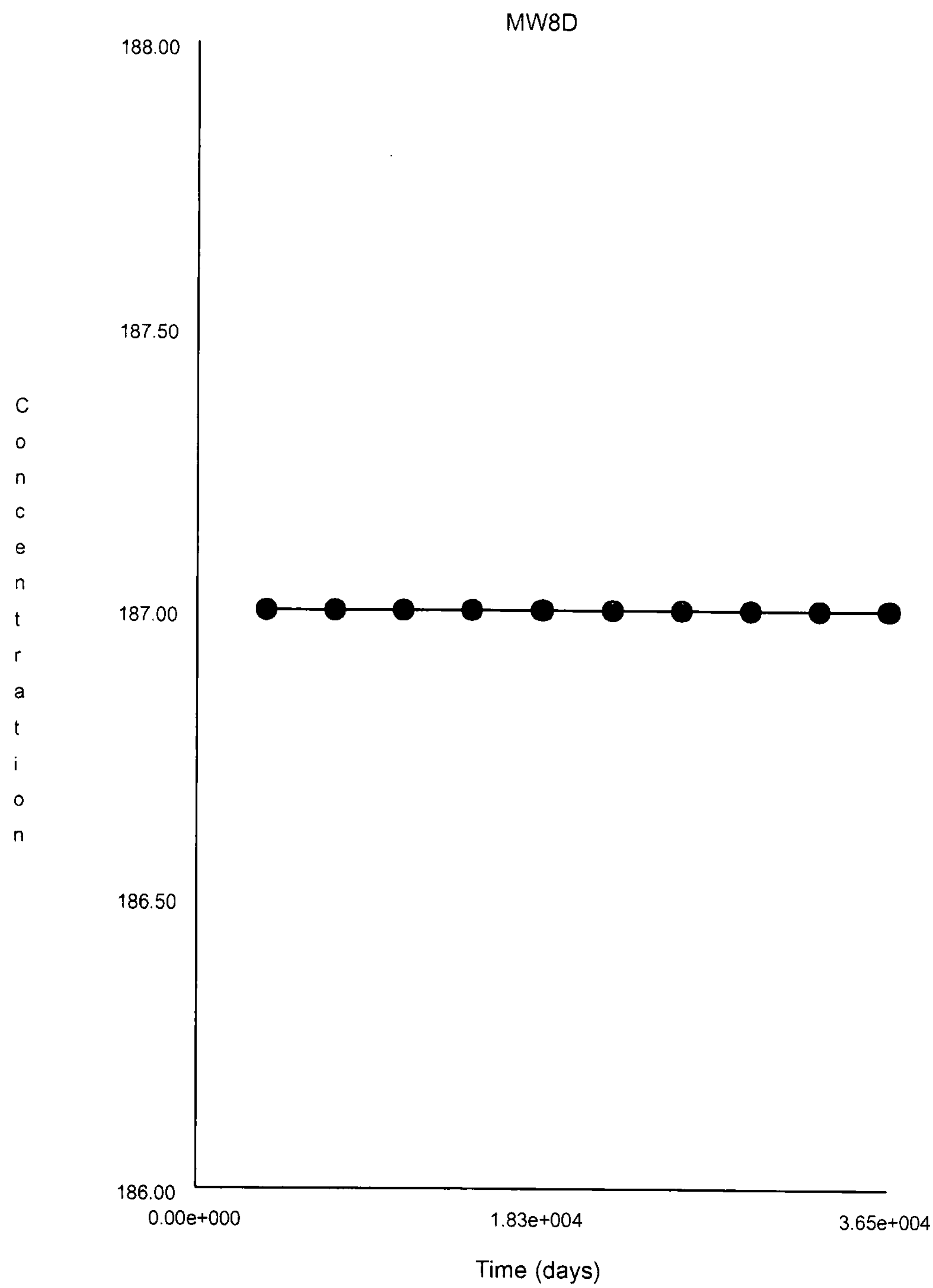


Figure 32 Pb conc. (ppb) vs time



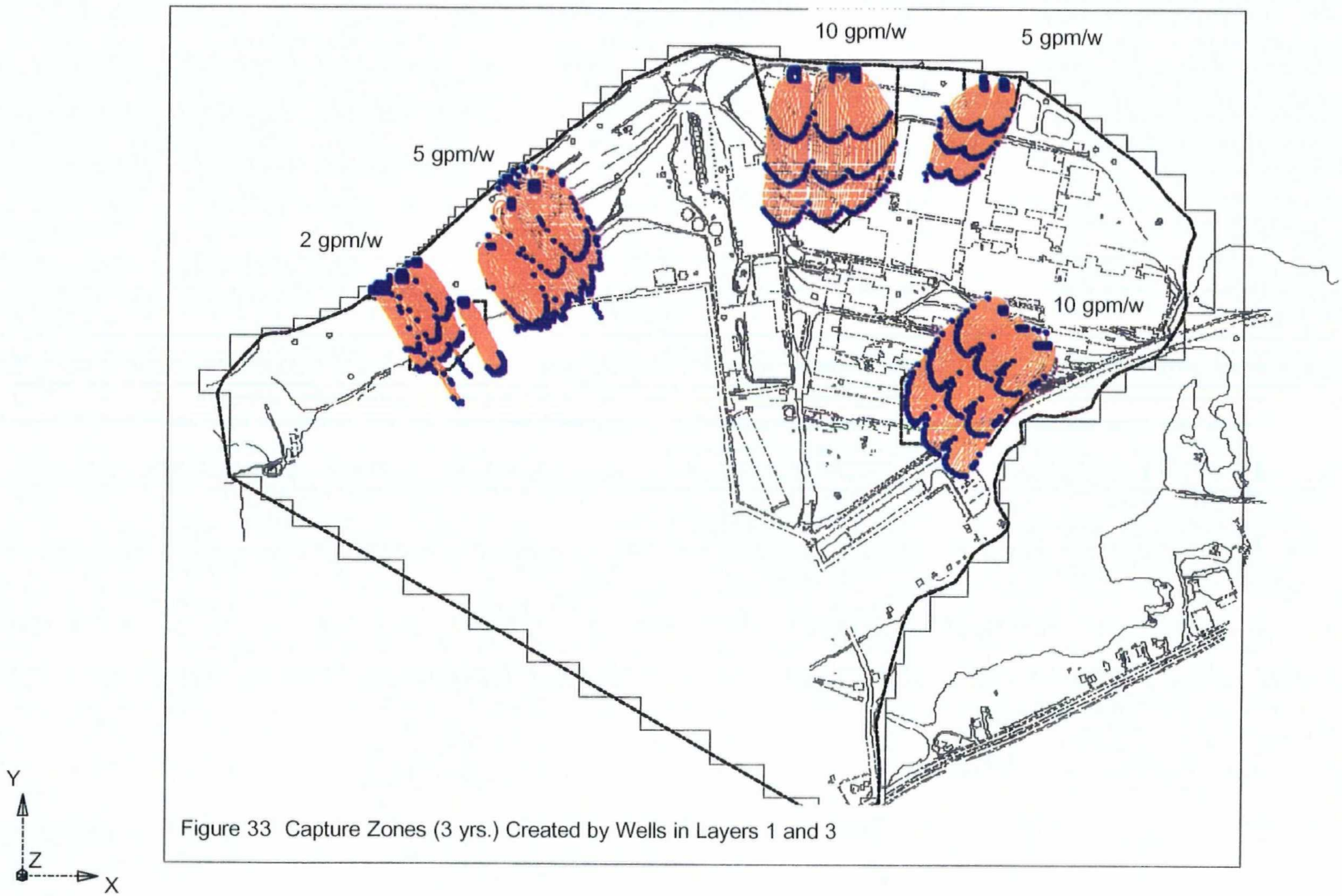


Figure 33 Capture Zones (3 yrs.) Created by Wells in Layers 1 and 3

400440

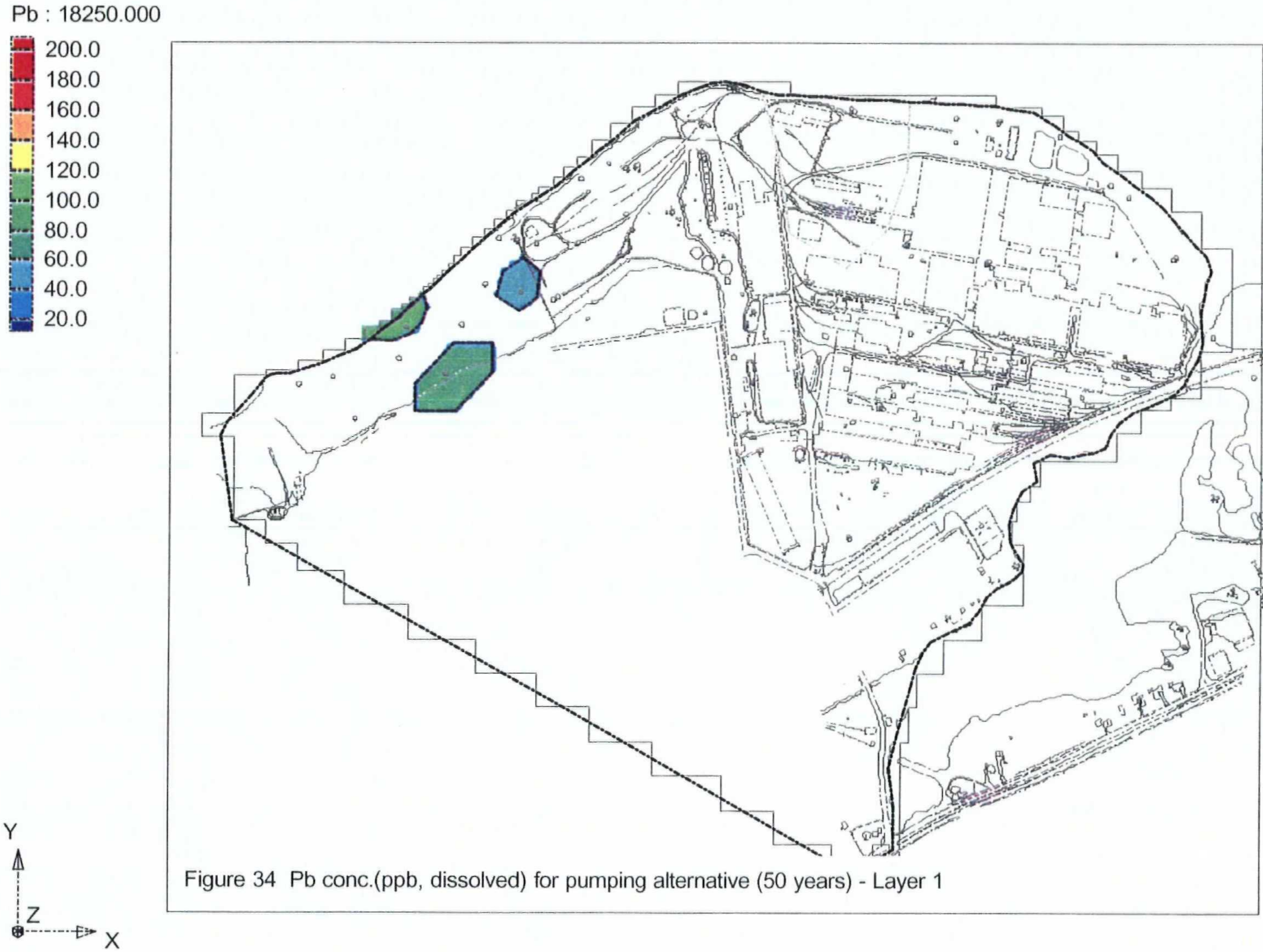


Figure 34 Pb conc.(ppb, dissolved) for pumping alternative (50 years) - Layer 1

400441

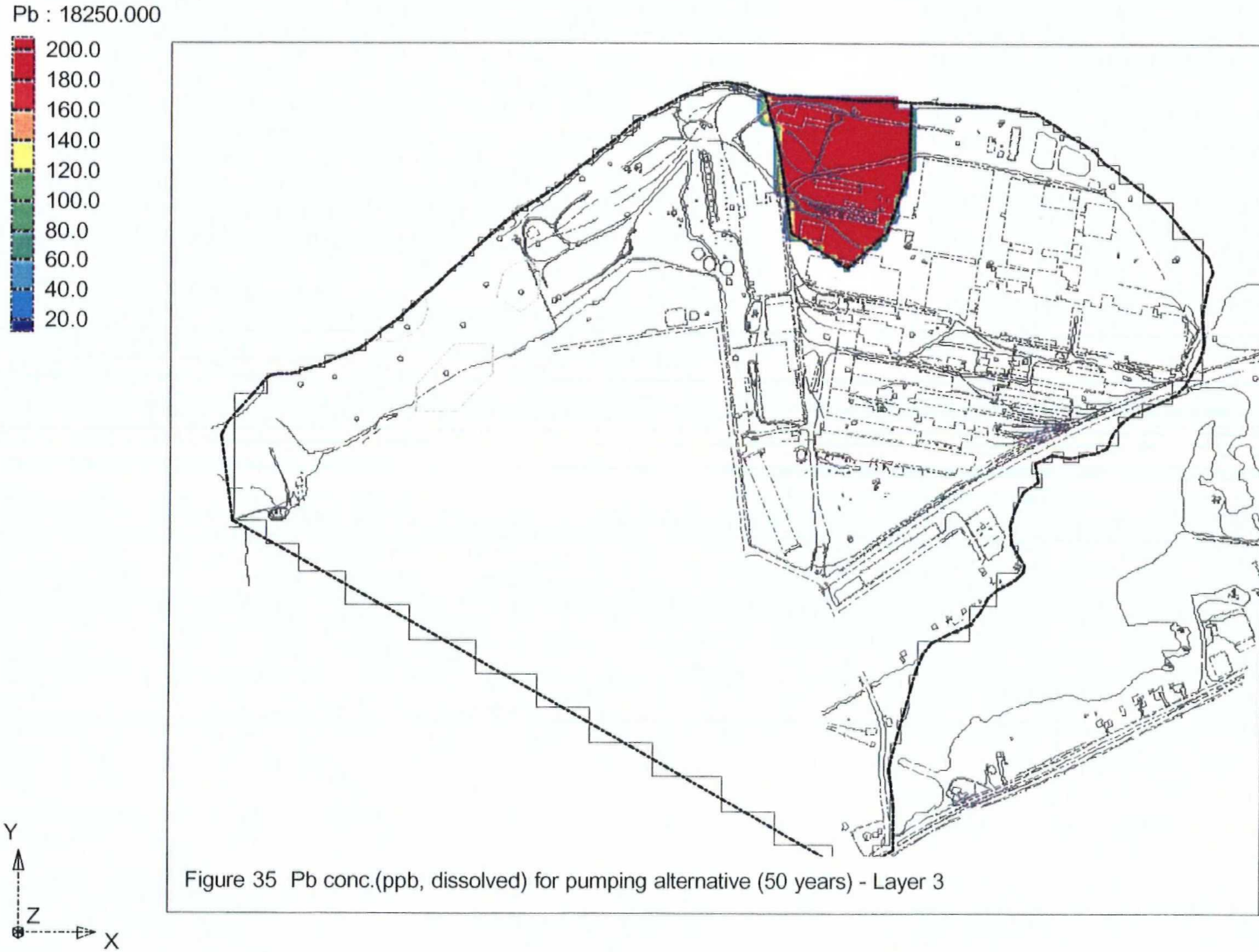
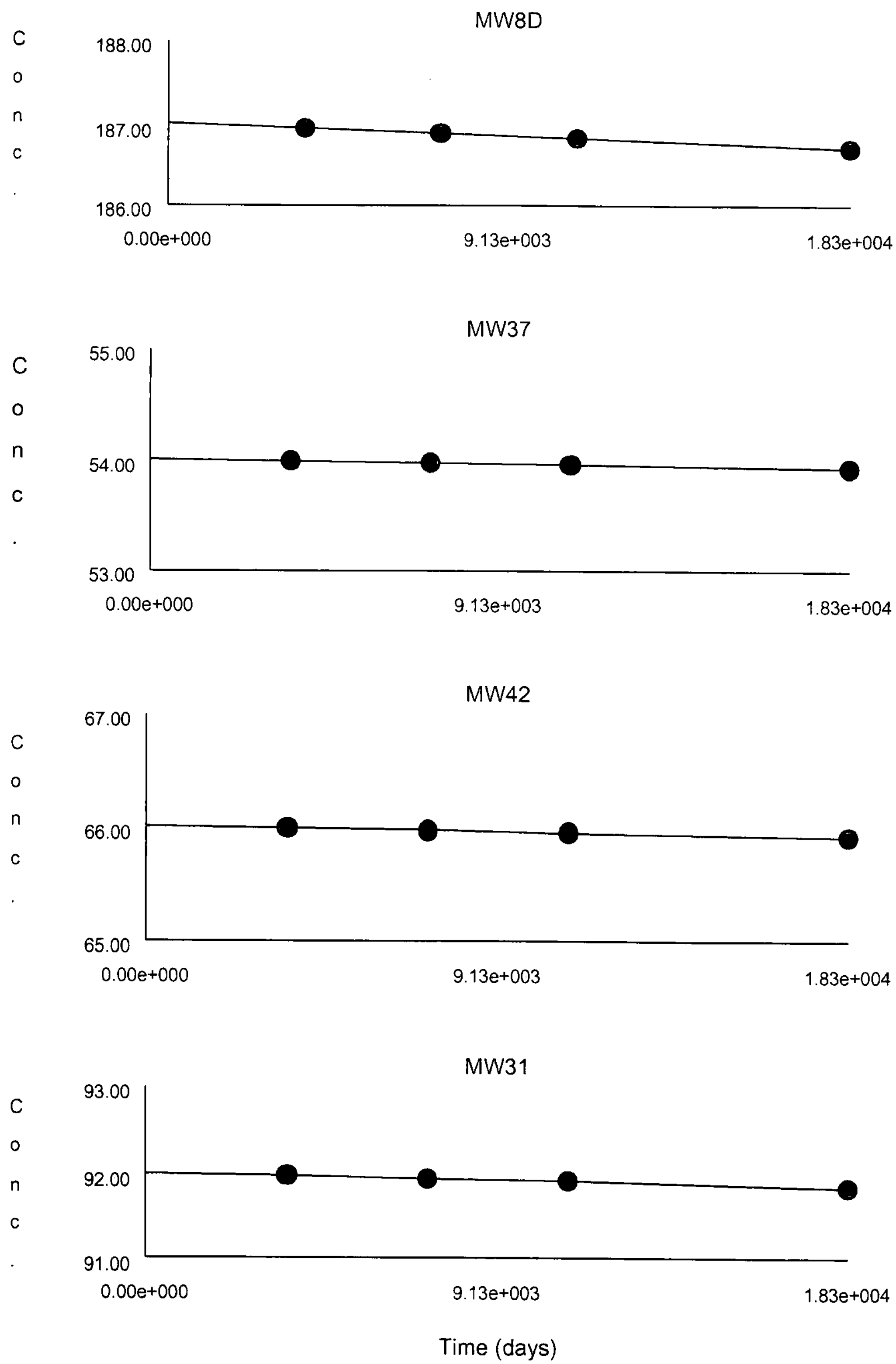


Figure 35 Pb conc.(ppb, dissolved) for pumping alternative (50 years) - Layer 3

400442

Figure 36 Pb conc. (ppb) vs time



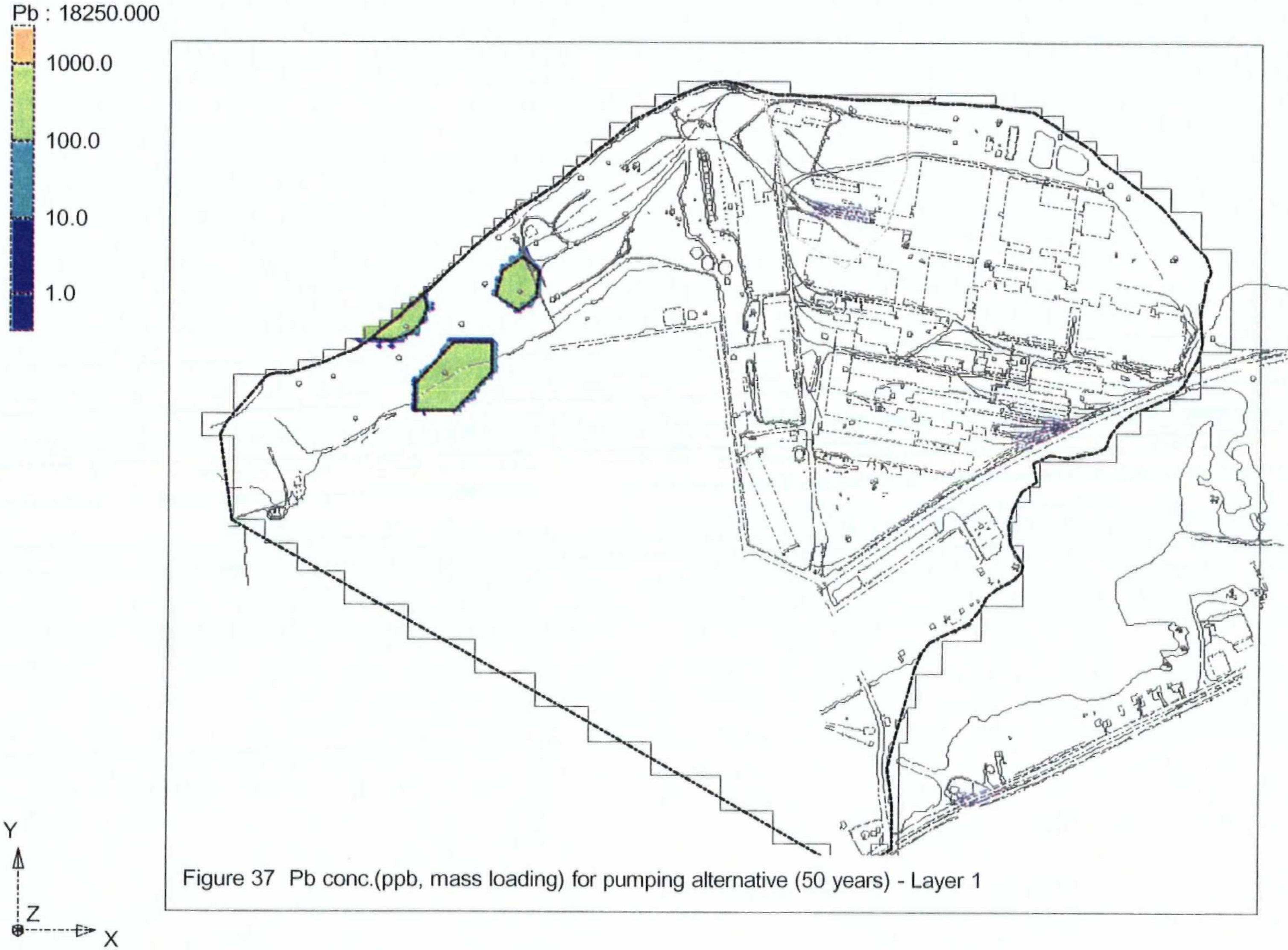


Figure 37 Pb conc.(ppb, mass loading) for pumping alternative (50 years) - Layer 1

400444

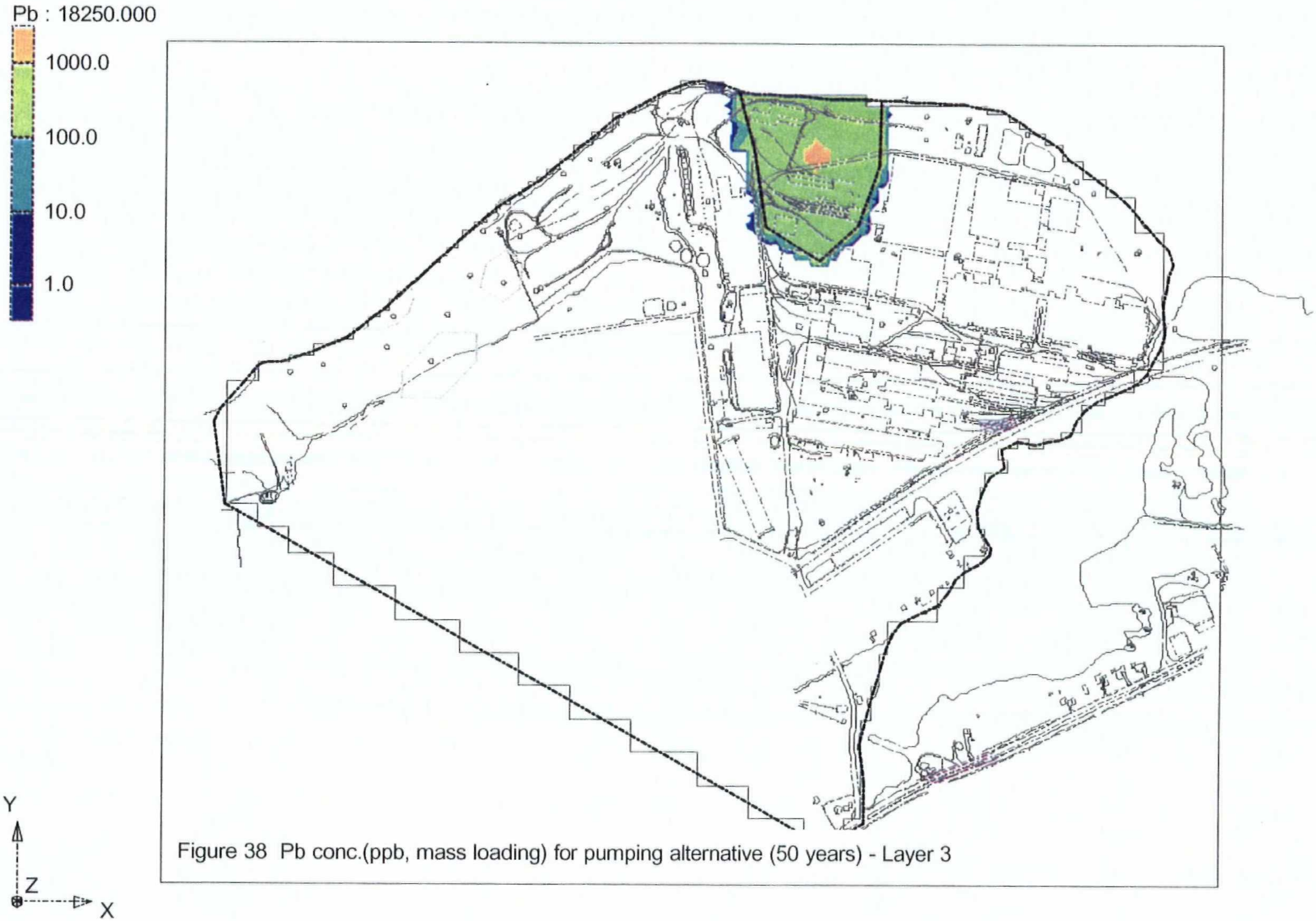


Figure 38 Pb conc.(ppb, mass loading) for pumping alternative (50 years) - Layer 3

400445

Figure 39 Pb conc. (ppb) vs time

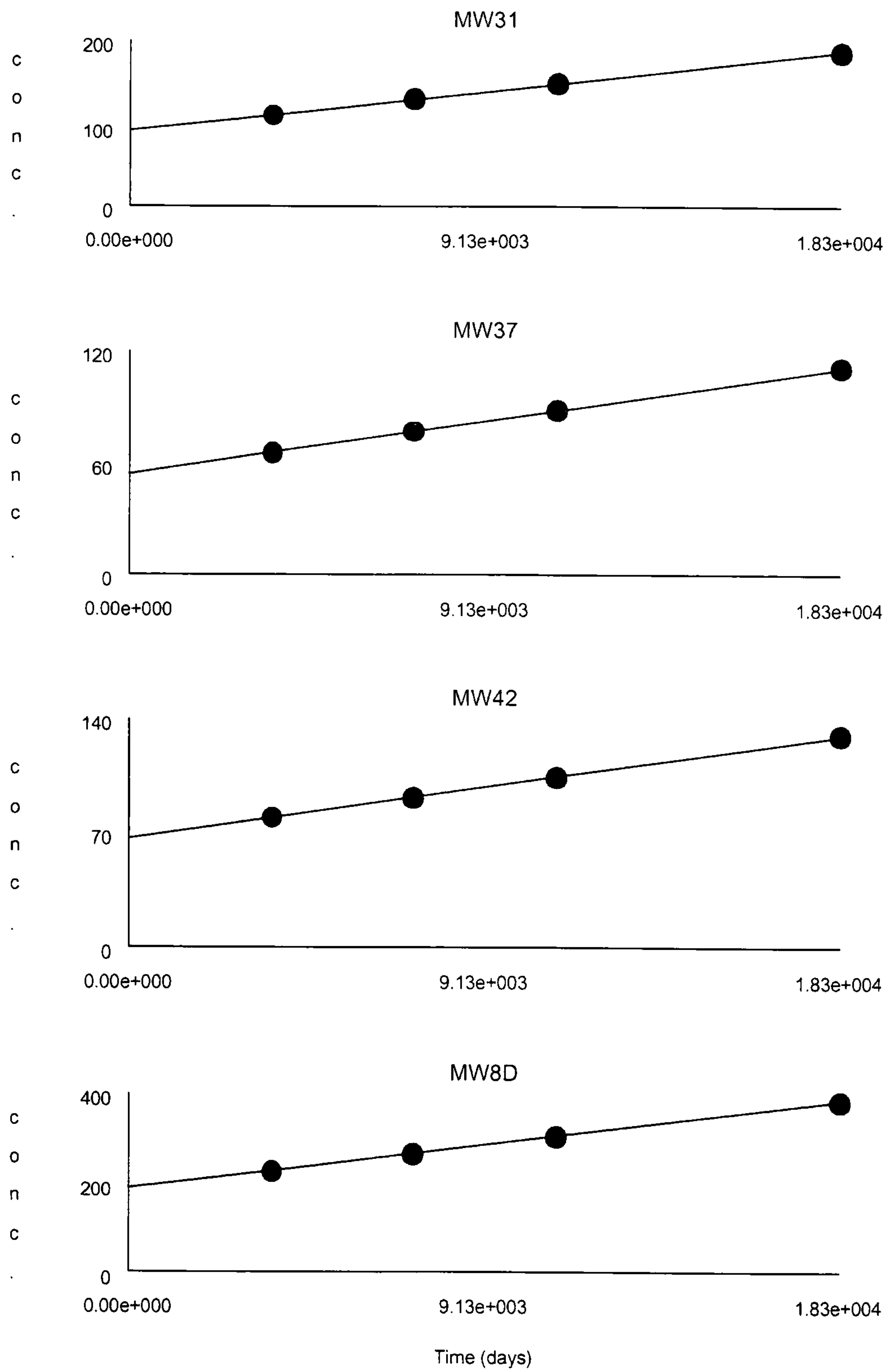
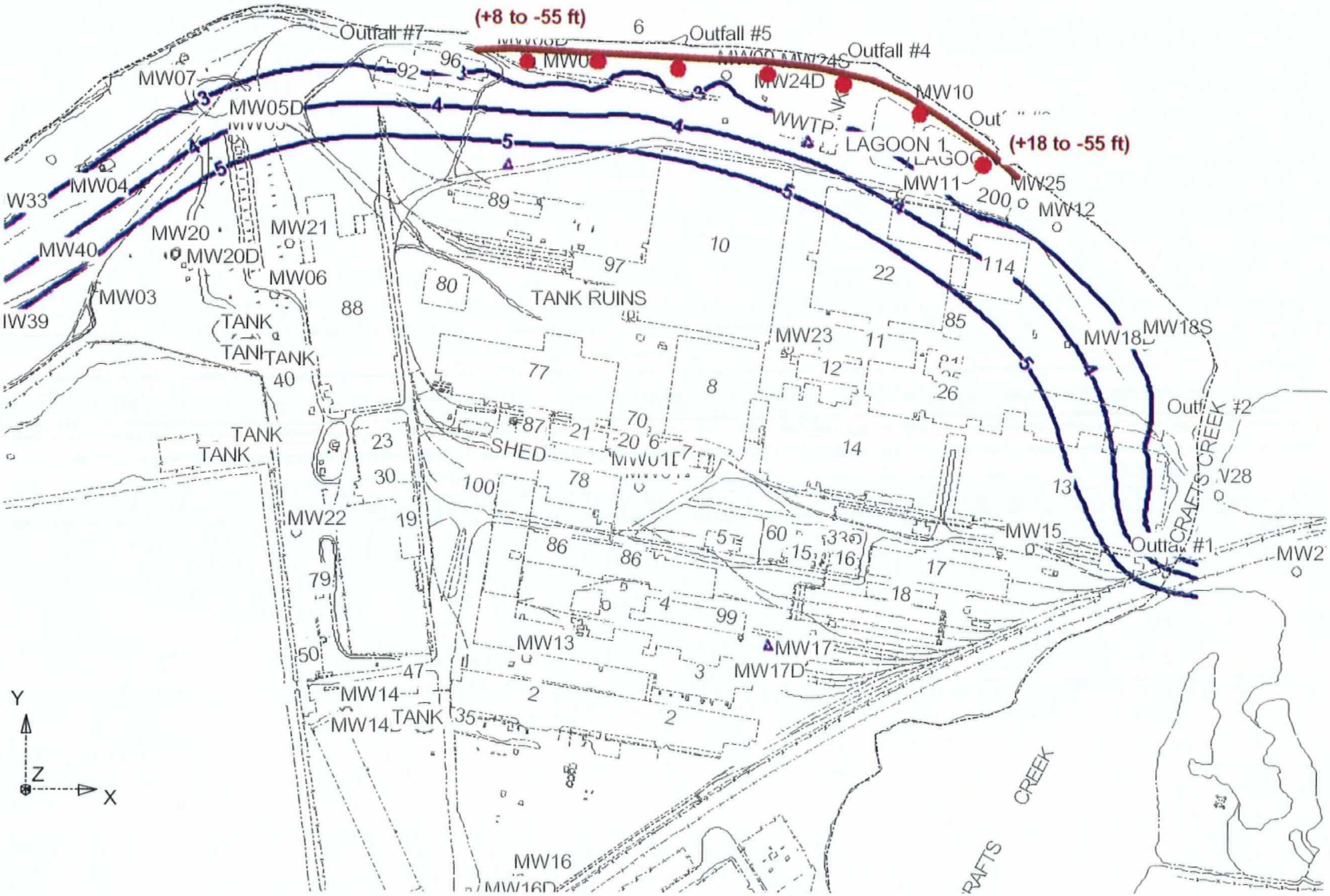


Figure 40 Cutoff Wall with Extraction Wells



400447

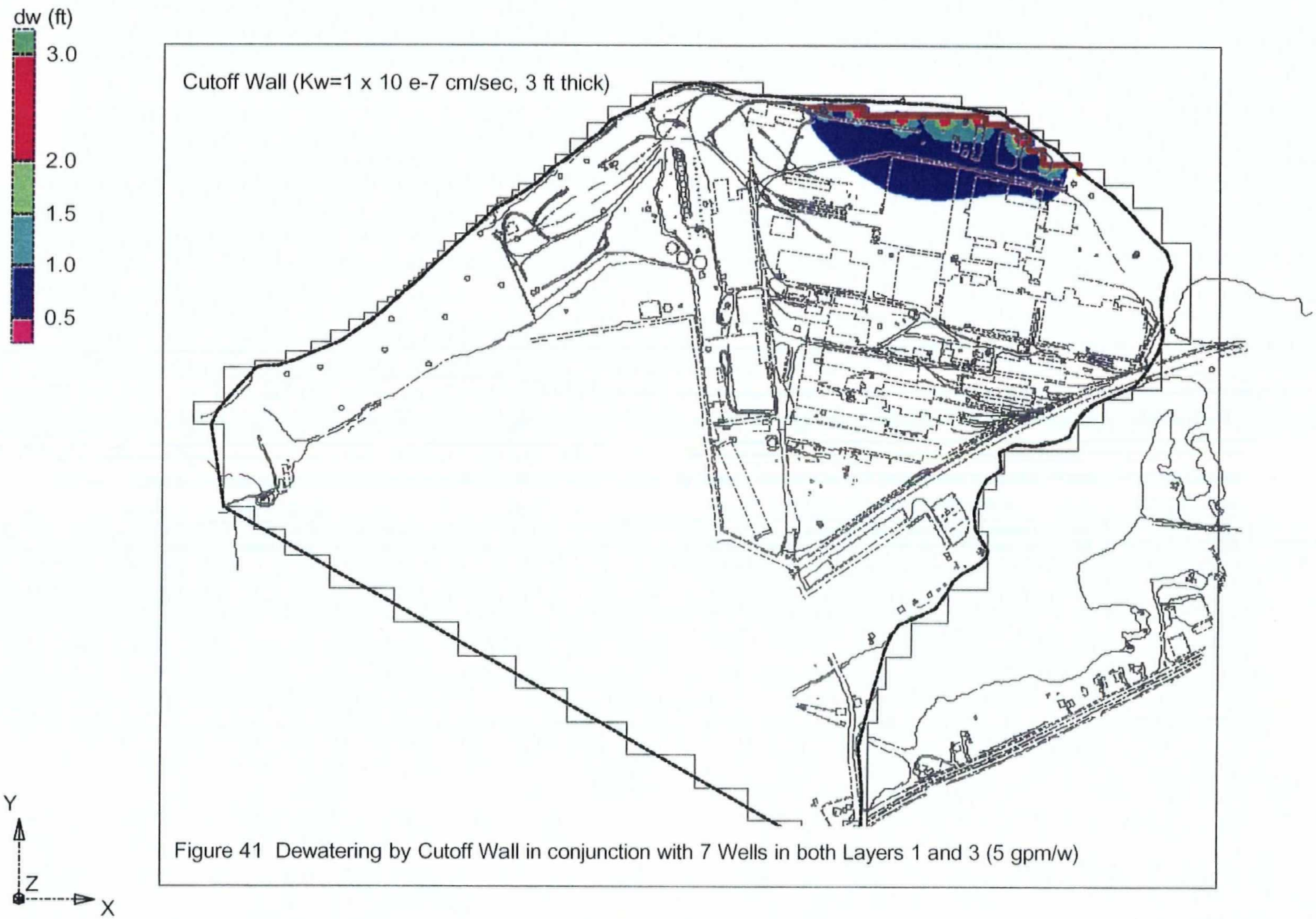


Figure 41 Dewatering by Cutoff Wall in conjunction with 7 Wells in both Layers 1 and 3 (5 gpm/w)

400448

400449

APPENDIX E

TECHNICAL IMPRACTICABILITY (TI) EVALUATION

APPENDIX E

TECHNICAL IMPRACTICABILITY EVALUATION ALTERNATIVE GW4 GROUNDWATER RESTORATION: EXTRACTION WELLS FOR PUMP-AND-TREAT

Purpose of Technical Impracticability Evaluation

This technical impracticability (TI) evaluation for the Roebling Steel Company Site (RSC), Operable Unit 5 (OU-5), is provided for the additional clarification of the TI aspects of Alternative GW4, Groundwater Restoration via Extraction Wells for Pump-and-Treat. The TI justification is based on the extremely long time required to remediate the site, the large volume of groundwater to be remediated, the high cost of Alternative GW4, and the extreme difficulty in extracting the inorganics from the aquifer. The TI waiver is being sought site-wide for the contaminated groundwater plume.

Site Background

The RSC is located on over 200 acres in Florence Township, Burlington County, New Jersey, in the vicinity of 40° 07' 25" north latitude and 74° 46' 30" west longitude. The site is located on the Bristol, PA 7.5 minute USGS topographic quadrangle map. West and southwest of the RSC, residential housing areas predominate. Most residential development adjacent to the site was constructed by the steel plant operators and used to house plant employees. The nearest residential dwellings to the site are approximately 100 feet from the property boundaries. A Penn Central (Conrail) track runs along the southeast boundary of the site. Areas on either side of this track are zoned for special manufacturing activities.

Newbold Island (New Jersey) lies in the Delaware River approximately 200 feet north of the site (see FS Report Figure 1-1). This island, owned by Public Service Electric and Gas Company, covers an area of approximately 500 acres and is largely undeveloped. The City of Burlington, located approximately six miles downstream from the site, uses the Delaware River for its water supply. The City obtains water both directly from the Delaware River and indirectly through shallow wells located on Burlington Island. The Delaware River also supplies water to the City of Philadelphia, farther downstream.

The RSC was actively used from 1906 to 1985 for various industrial purposes, but primarily for the fabrication of steel wire. The wire production process resulted in the generation of significant quantities of waste materials in both liquid and solid forms. The majority of liquid wastes were discharged to Crafts Creek and the Delaware River. Large quantities of solid wastes including slag, mill scale, used refractory materials and other production residues were disposed at the site. Numerous buildings, storage tanks and piping systems were abandoned at the site. On-site groundwater, as well as sediments in the Back Channel of the Delaware River, are contaminated with inorganics (e.g., heavy metals such as arsenic, beryllium and lead). As a result of on-site contamination, the site poses excess carcinogenic and non-carcinogenic risks primarily to individuals who may be present on the site for significant time periods.

TI Evaluation

This technical impracticability evaluation for the attainment of groundwater ARARs includes descriptions of: the site geology and hydrogeology; the development of conceptual and numerical groundwater flow models used to develop groundwater predictive simulations; the development of a contaminant transport model used to simulate current metals contamination in groundwater and predict future metals concentrations; the remediation potential of the site; and an economic assessment of Alternative GW4.

Geology and Hydrogeology

The RSC is underlain by a sequence of fill materials, sands, clays, silts, and gravels. These soils, excluding the fill material, appear to correlate to the Raritan or Magothy Formations of the Cretaceous Age which outcrop along the eastern bank of the Delaware River throughout much of southern New Jersey. These two formations are major aquifers of the Atlantic Coastal Plain in New Jersey.

Seventeen soil borings were drilled to install groundwater monitoring wells and to assess stratigraphy. The stratigraphy of the site consists of a shallow, unconfined Upper Aquifer and a confined Lower Aquifer. These two aquifers are separated in most parts of the site by a confining layer; the Upper Clay unit. However, the Upper Clay unit is not horizontally continuous across the entire site. In areas where this clay unit is absent, the two aquifers are hydraulically, as well as physically, connected.

Near the center of the site, a downward hydraulic gradient was observed through the Upper Clay unit. This is in agreement with regional data that show a general downward gradient from shallow to deeper aquifers in the area. However, at paired wells located near the Delaware River, and completed in the two sand units (Upper and Lower, respectively), the potentiometric heads fluctuated such that the gradient varied over time with the flow upward at times and downward at others. This variability is likely due to tidal influences on water levels and the absence of a confining layer at these well locations resulting in the two layers acting as a single hydrologic unit where the clay layer is absent.

The metals of concern in the groundwater at the RSC are arsenic, beryllium and lead. Under a normal range of pH these metals are virtually immobile in groundwater. The metals prefer to partition to the solid portion of the aquifer instead of dissolving and moving with the groundwater. This relationship has been measured and is called the distribution coefficient (K_d) and is defined as the mass of solute on the solid phase per unit mass of solid phase divided by the concentration of solute in solution. The K_d can vary from zero to several thousand ml/g for the constituents of concern. Contaminants with values of K_d over 10 are basically immobile (Freeze and Cherry, 1979). The approximate K_ds for arsenic, beryllium and lead under the pH conditions at the site are 29 ml/g, 790 ml/g and 890 ml/g respectively. Therefore, these metals are basically immobile in the groundwater system.

The values of the Kd for arsenic, beryllium and lead are adopted from Appendix A, Table 5 of Chapter 250 of Title 5, Environmental Protection of the Pennsylvania Code. This site is in the same physiographic region as Pennsylvania, which is just across the river from the site.

There is no specific site data for soil pH, clay content, organic carbon content, mineralogy or sulphate chemistry for the site. However, there are pH values for the groundwater at the site. The pH in the Upper Sand Aquifer ranges from 5.6 to 7.0; in the lower aquifer from 4.96 to 6.02, and in the slag area from 6.12 to 8.63. The pHs are in the neutral range in the slag area and the Upper Sand Aquifer and slightly acidic in the Lower Sand Qquifer. The limiting metal for cleanup is the lead which is in the upper aquifer and the slag area in a neutral pH zones. According to the EPA document "Understanding Variation in Partition Coefficient, Kd Values", Volume II, EPA 402-R-99-004B, August 1999, with equilibrium lead concentrations ranging between 37 and 187 ug/l and soil pH values ranging from 6 to 8, the values of Kd for lead range between 900 and 4970 ml/g. The value used in the model for the lead Kd was 890 ml/g which is the most conservative value of the range (shortest cleanup time) that is appropriate for the site.

Development of Conceptual and Numerical Groundwater Flow Models

A site-specific conceptual model (see Appendix D of this FS Report) was developed for the site. The conceptual model included the following three layers: the Upper Sand/Fill unit (Layer 1), the Upper Clay unit (Layer 2), and the Lower Sand unit (Layer 3). The conceptual model was used to develop a calibrated flow model for the site using the USGS MODFLOW 96 code. Using a variable-spacing grid, the entire model domain consisted of 37,638 discrete cells and 51,088 nodes. The model was successfully calibrated to previous groundwater elevation measurements at the RSC.

Development of a Contaminant Transport Model

A contaminant transport model was developed, using USGS MODPATH 96 and MT3DMS, to simulate the current metals contamination in the groundwater at the site and predict the metals concentrations in the future under natural attenuation and other various remediation scenarios. The flow field from the calibrated flow model was used for the transport modeling simulations.

The initial plumes were developed from measured exceedances in the monitoring wells at the RSC. The plumes included three lead and one arsenic plume in the Upper Sand Aquifer and one lead, one arsenic, and one beryllium plume in the Lower Sand Aquifer. The concentration used for each plume was the highest concentration from data from the RI Report.

Each plume is separate with boundaries extending from midpoints between the impacted monitoring well and adjacent monitoring wells in which the metal was not detected at a concentration above groundwater quality standards.

This base case transport model assumes that there is a continuing source of metals contamination and that it has not been removed. Constant mass loading concentrations were varied to determine the mass loading required to produce the concentrations that are currently observed in the Upper and Lower Aquifers, assuming a 50-year period of loading. The simulations were run for an additional 50 years to observe the predicted concentrations and plume geometry and to compare the results with the current plumes to determine concentration and geometry changes over the 50-year period. The modeling shows that with constant mass loading of arsenic, beryllium and lead, the concentrations in the plumes increase with time, but the plume geometry does not expand.

Additional transport modeling was performed simulating the plume concentrations over time for the following four scenarios: source removal and natural attenuation; source removal and active pump-and-treat; no source removal and active pump-and-treat; and no source removal and hydraulic containment, using a cutoff wall in conjunction with extraction wells.

Site Remediation Potential

Based on the groundwater flow and transport modeling, the following conclusions were developed regarding the site remediation potential:

- Under current conditions, with no source removal (i.e., No Action for soil and groundwater and no depletion of source material), the arsenic, beryllium and lead contaminant plumes will double in concentration but will not expand;
- If the sources are removed, the metals contaminant plumes would naturally attenuate under current groundwater flow conditions (via dilution and dispersion) in approximately 90,000 years;
- If the sources are removed, the metals contaminant plumes would be remediated in approximately 35,000 years if a pump-and-treat system were installed, at 93 gpm. The conceptual design includes 15 extraction wells, which are assumed to be fully penetrating in both Layer 1 and Layer 3. Seven of the 15 wells would extract a total of 23 gallons per minute (gpm) from Layer 1 and the remaining eight wells would extract 70 gpm from Layer 3. The combined pumping rate of 93 gpm would then be sent to a treatment system;
- If the sources are not removed, the metals contaminant plumes would never be remediated, even if a pump and treat system were installed;
- If the sources are not removed and hydraulic containment is achieved using a cutoff wall in conjunction with extraction wells, the metals contaminant plumes will never be remediated.
- Approximately 1.7 trillion gallons, of groundwater, over a 35,000-year period, would need to be remediated under the pump and treat scenario with source removal; and
- Extracting inorganics from the aquifer would be extremely difficult due to the high partition coefficient values of the controlling metals, such as lead (890 ml/g), arsenic (29 ml/g), and beryllium (790 ml/g).

Economic Assessment

The estimated construction cost for Alternative GW4 would be $3,455,000 and the annual O&M cost would be $768,000. Based on a seven-percent discount rate and a 30-year period, the total present worth of this alternative would be $13,043,000. An additional capital cost of $649,931,000 would also be incurred to remove source materials, since the groundwater modeling has demonstrated that the groundwater ARARs could only be achieved if sources are removed.

For the purpose of developing, evaluating, and comparing alternatives, a 30-year remediation time frame is typical. For Alternative GW4, with source removal, groundwater modeling suggests that the time frame to achieve ARARs would be approximately 35,000 years. A present worth analysis for a 35,000-year remediation period was performed using the following assumptions:

- The groundwater treatment system would need to be replaced every 30 years at a cost of $3,455,000 based on an estimated equipment design life;
- O&M costs would be $768,000 annually for the 35,000-year remediation time frame;
- Five-year reviews at a cost of $25,000 per review would be performed for the 35,000 year time frame; and,
- A seven percent discount rate is inclusive of inflation and return on investment.

Based on these assumptions, the net present worth analysis for the estimated 35,000-year remediation period results in a total present worth of $15,015,000. As anticipated, due to the time value of money and the extremely long time frame, the present worth analysis does not indicate a substantial cost differential beyond the 30-year analysis time frame.

TI Summary

Based on historical RI data, current site conditions, the preliminary design of the treatment system, and the contaminant modeling performed as part of the FS, the factors that warrant the decision to declare groundwater restoration as technically impracticable include:

- The 35,000-year period required to remediate the 1.7 trillion gallons of contaminated groundwater;
- The high present worth cost of $13,043,000 for groundwater restoration (for the first 30 years);
- The significant difficulty in extracting inorganics from the aquifer due to the high level of contaminant sorption and locking into soil;
- The large 200-acre (8.7 million ft^2) spatial area of site-wide contamination;
- The replacement of the treatment system every 30 years of the 35,000-year remediation period, based on the typical design life of equipment; and
- The inability to achieve groundwater ARARs or target cleanup levels in a reasonable timeframe.

Groundwater use restrictions would be required to be maintained until NJ-GWQS were achieved, and impacts to sediments, if any, would persist until concentrations were substantially reduced.

Alternative Remedial Strategy

As discussed previously, Alternative GW4 is not a viable strategy for achieving ARARs or remediating groundwater at the site within a reasonable timeframe. A waiver from achieving NJ-GWQS is warranted. In addition, aqueous plume remediation would require that all contaminant sources are removed. The alternative strategy is the implementation of the Limited Action alternative for groundwater, with long-term monitoring of sediments, surface water and groundwater to assess the potential for unacceptable ecological risks. The long-term monitoring program would be performed in accordance with a Long-Term Monitoring Plan, which would be developed in accordance with the Final OSWER Monitored Natural Attenuation Policy (USEPA, 1999), following adequate delineation of the groundwater plume.

The Limited Action alternative (i.e., use restrictions and a CEA) is protective of human health, since it provides control of the exposure pathway. This alternative would not mitigate ecological risks if the groundwater causes degradation in sediment quality and impacts to ecological systems. However, based on historical data that show sediments were impacted predominantly from outfall discharges, there is no definitive evidence that ecological impacts resulted from contaminated groundwater (discharging to the Delaware River). Monitoring of sediments and surface water could be performed to determine if groundwater is causing unacceptable ecological impacts. Should potential "triggers" signal that the selected remedy is not performing satisfactorily, a re-evaluation of options and the development of an alternative strategy to mitigate these impacts would need to be performed. The criteria (USEPA, 1999) that signal unacceptable performance of the selected remedy and indicate when to implement contingency measures, include:

- Contaminant concentrations in groundwater at specified locations exhibit an increasing trend not originally predicted during remedy selection;
- Future monitoring indicates unacceptable impacts to sediments or surface water;
- Near-source wells exhibit large concentration increases indicative of a new or renewed release;
- Contaminants are identified in monitoring wells located outside of the original plume boundary;
- Contaminant concentrations are not decreasing at a sufficiently rapid rate to meet the remediation objectives; and
- Changes in groundwater use will adversely affect the protectiveness of the remedy.

The alternative remedy is based on the current data and is subject to change based on future data that may be collected and demonstrates differing conditions. Five-year reviews, as required by CERCLA, also serve to evaluate whether conditions differ sufficiently from those expected to merit a re-evaluation of alternatives.